THE ENGINEER.

Some Yorkshire Machine Tools.

SOME YORKSHIRE MACHINE TOOLS.

It would be fruitless to deny that the machine tools of Yorkshire have not a universally good reputation. The reason is not far to seek. Many of the smaller makers work for a cheap market. They do not get good prices for their products, and the products are not worth more than they get for them. They serve, nevertheless, a distinctly useful purpose. Those that can afford the best tools need not go to them, whilst those with less money at disposal find it very convenient to be able to procure cheap machines which are good enough for their immediate needs. It is frequently said that a bad machine tool is not cheap at any price. That is far too sweeping an assertion. There are certain jobs which can be turned out quite sufficiently well on an indifferent machine, and for which it would be uneconomical to supply a better tool. On the other hand, if we intend the statement to imply that trouble with breakdowns and maladjustments runs away by degrees with the initial saving, there is more truth in it; but we have still to bear in mind that there are users who can afford the few shillings or pounds from time to time to replace broken parts or make repairs, but who would be unable to find the capital to buy first-class tools. We therefore contend that the cheap tool makers of Yorkshire serve a distinctly useful purpose.

But there is also in Yorkshire a totally different class of makers—makers who can charge as much as the best Manchester firms, and whose reputation illuminates the shadows under which the Yorkshire tool labours. Their works, generally speaking, are smaller, not so up-to-date as the best Lancashire shops; but the work produced is no whit inferior. Even in the matter of buildings and management Yorkshire is coming into line with other counties, and more than one firm have already started upon or schemed out plans for remodelling their shops, and others have already provided themselves with the best adjuncts of modern manufacturing works. This is as it should be. Fundamentally, there is no more reason why Yorkshire should not turn out first-class tools than why Manchester, or Coventry, or Glasgow should. It is only the smallest makers who keep its reputation down, and we have already shown that they are necessary.

It would not be uninteresting to those who study the geographical disposition of works to enter into the reasons why such a number of quite little firms should have sprung up in Yorkshire, and to discuss the plans for amalgamation of them which have been talked about from time to time. Very likely the key to the whole matter would be found in the character of the people. Too many wished to be masters and employers. But fascinating as the subject might prove, we do not propose to enter into it, as our object in this present supplement is to show what is being done in the way of machine toolmaking in Yorkshire at present, and to show that many excellent tools are made there. It is scarcely necessary to observe that in the limited space at our disposal it is not possible to deal with even all the better Yorkshire firms. Some names are omitted for this reason, and others because the makers did not see their way to accept our offer to describe their machines. We deal with representative tools of some nine separate firms. Most of the firms are well known; some of them have world-wide reputations.

DARLING AND SELLERS, LIMITED.

On this and the next page several high-class tools by Darling and Sellers, Limited, of Keighley, are illustrated.

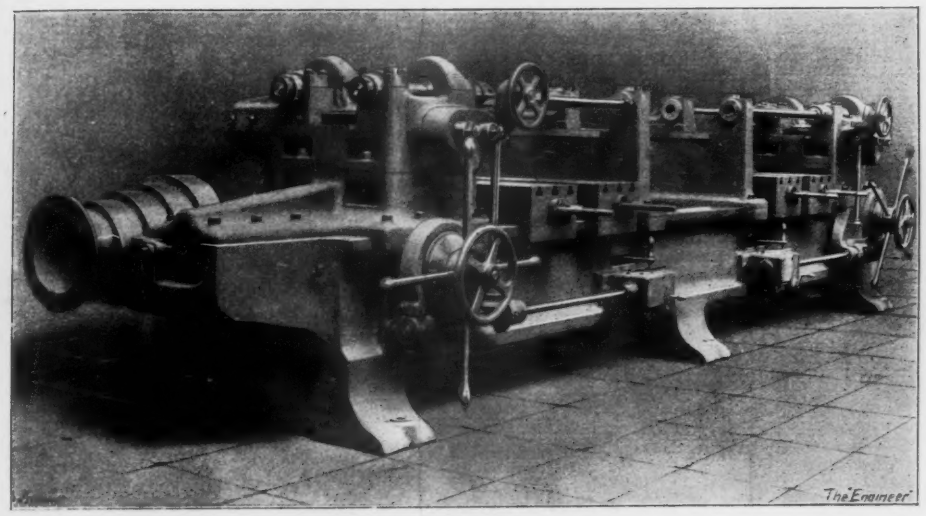


Fig. 1—QUADRUPLE HORIZONTAL BORING MACHINE—DARLING AND SELLERS

A feature that is immediately noticeable in all is the guarding. A good deal of attention has been directed to this subject lately by the four papers read a few weeks ago at the Institution of Mechanical Engineers. The consensus of opinion, as there expressed, which we heartily endorse, was that the guarding of machine tools should be the manufacturer's work, and that it should be incorporated in the design of the tools. If this plan is followed, no material is so satisfactory, taken altogether, as cast iron for the guards. It has all the qualifications that are desirable, and is the only material which can be really embodied in the machine itself. Most machine tool makers fully recognise this fact, and not a little care is exercised, both to make the guarding effective and in keeping with the design. The tools under consideration exemplify this, guarding being carried as far as necessary, and entering neatly into the design of the tools.

An interesting machine is the quadruple horizontal boring machine illustrated by Fig. 1, designed in the first instance for dealing rapidly and effectually with "donkey cylinders" and pumps; this special tool, as will be readily seen from the illustration, is well adapted for a great variety of work. The two back spindles with their stays are adjustable in relation to the front spindles, the distance from centre to centre is variable from 5½in. to 14in. The saddles on which the boring heads are mounted have quick-hand motion, fine hand adjustment and reversible automatic feed, with four changes instantly operated while the machine is running. The tables in this case are without vertical adjustment, special "cradles" or jigs being provided for each size of article to be dealt with. When the machine is not to be used for repetition work, special elevating tables are substituted by the makers.

It will be noticed that these tables are very narrow, and four in number, two for each half of the machine. This allows considerably more elasticity than the usual practice of having one broad table for each head, seeing that for long work the two tables can be opened out to any required distance apart, while on short jobs they may either be brought close together, or one of them removed altogether. With this in view, both tables and stays are arranged to be very readily removed from the bed. The spindles, which run in parallel bearings, are driven by case-hardened worms and phosphor bronze worm wheels. Both worms and wheels are completely encased, the casing forming oil baths; means of disconnecting the drive of either spindle from that of its fellow on the same head is provided. Essentially, this tool consists of two duplex machines mounted on one bed, the driving and feed motions being quite independent for each pair of spindles. Below are a few of the leading dimensions of the machine illustrated:—

Maximum distance between ends of spindles	10ft.
Minimum distance between ends of spindles	5ft. 6in.

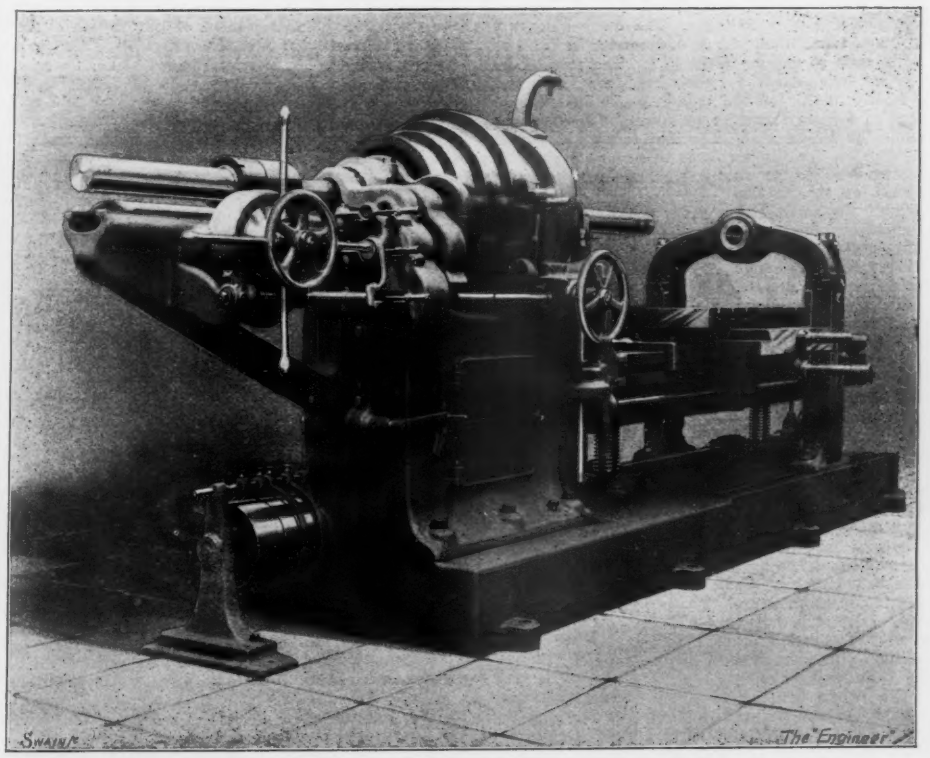


Fig. 2—HORIZONTAL BORING MACHINE—DARLING AND SELLERS

Maximum centres of spindles, measured transversely ...	1ft. 2in.
Minimum centres of spindles, measured transversely ...	5½in.
Distance from centres of spindles to top of tables	1ft.
Maximum diameter of hole to be bored	10in.

The bed is 17ft. 8in. long by 1ft. 10in. across. It is supported on three feet, cast solid with it, and has planed

slide-ways on its upper face to receive boring heads and work tables. The two duplex boring heads are right and left-hand, and are provided with independent, longitudinal self-acting motion in a direction towards each other, also with hand motion for setting in or withdrawing from the cut. Two boring spindles are carried on each head. They are placed in line with the length of the bed, one being a fixture and the other adjustable transversely by screw for varying widths of centres. The spindle ends are tapered internally, and fitted with threaded caps and cotters for attachment of bar. The spindle drive is independent for each head, and steps, and the head is double back-geared, so that twelve changes of speed can be obtained. The steps are 18in., 22in., 26in., and 30in. diameter, and they take a 4in. belt. The two back gear ratios are 3·7 and 13·6 to 1. A lever in front of the head permits of rapid change from one gear to the other. There are six changes of feed, positively driven, with reverse. They are controlled by levers, and may be altered whilst the machine is in motion. Both bar and table have self-acting motion. The gear for elevating the table consists of hardened steel worms, bronze wheels, and large screws; it can be controlled by hand ratchet motion or by power through illustrated by Fig. 3. We have so often dwelt upon the necessity for ample surface and more than ample rigidity in milling machines that we are almost ashamed to insist upon it again, but as machines are still made in which we think sufficient attention is not paid to these vital points apology is scarcely necessary. The present machine aims at securing for the Universal miller the rigidity of the simple tool. Where there are many moving parts and surfaces in contact this is only to be secured by careful adjustment and good wide bases for the slides and tables. For horizontal milling the outer end of the arbor is supported by the overhanging arm,

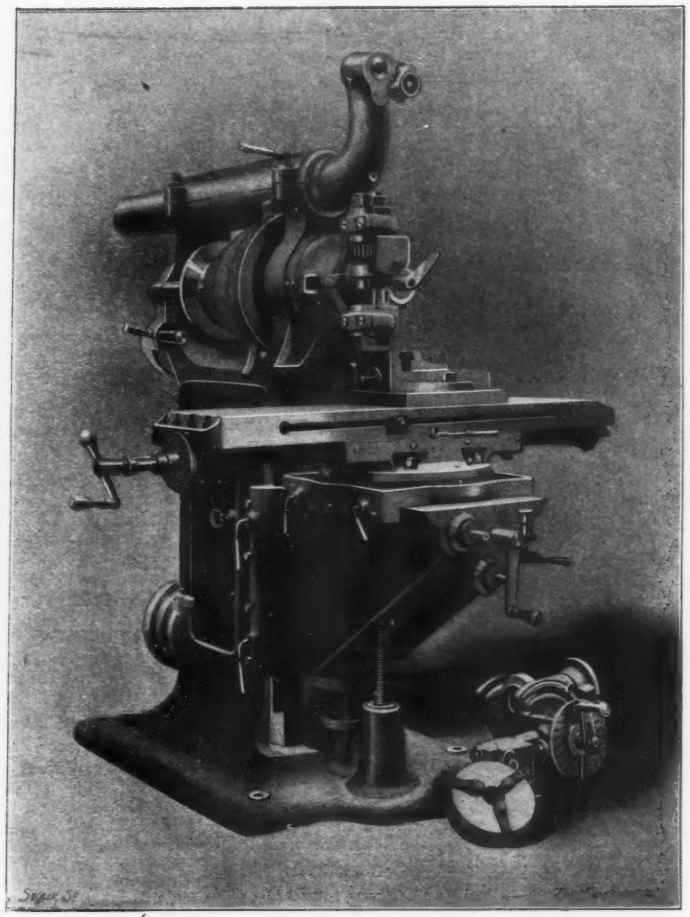


Fig. 3—UNIVERSAL MILLING MACHINE—DARLING AND SELLERS

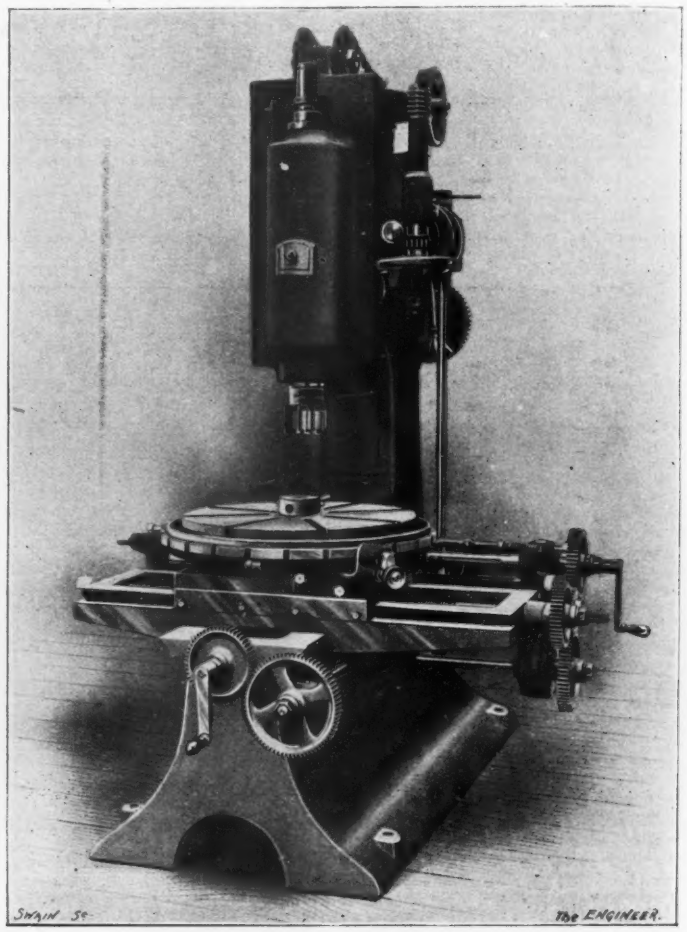


Fig. 4—VERTICAL MILLING MACHINE—DARLING AND SELLERS

is from a five-speed cone at each end of the bed, through spiral, spur, and worm gearing. The driving cones are 10in., 12in., 14in., 16in., and 18in. diameter for 3½in. belt, and the ratio of gearing is 16 to 1. The rates of feed, which are independent for each head, are 1in. in 8, 16, and 24 revolutions of the spindle. An instantaneous change of feed and reverse by levers, without stopping the machine, is provided. The four saddles have planed slide-ways on their upper faces to receive work tables; provision is made for clamping them down securely in any position to suit the length of the work, but no mechanical means of moving them along the bed is provided. The four work tables measure 1ft. by 2ft. 6in., the long dimension being at right angles to the length of the bed. They are mounted on the saddles, and have transverse movement thereon by screws for adjustment of work to centres, and they are provided with planed T slots for bolting down the work. Two duplex stays, one for each boring head, are provided. Each stay can be clamped to the bed between the tables in any position; it carries two bushed and capped boring bar bearings, one fixed in line with the fixed spindle, and the other with adjustment corresponding to that of the adjustable spindle. The gears in this, as in all machines by these makers, are cut from the solid throughout. The weight of this machine is 5 tons 15 cwt.

In Fig. 2 a horizontal boring machine, also by Darling and Sellers, is illustrated. The whole of the gearing, it will be seen, is placed in front of the cone, thus permitting the latter to be of large diameter without adding to the cumbersomeness of the machine, and, furthermore, leaving the cone quite clear, so that there is nothing to interfere with the belt being inclined at any angle, as there is when the back gear is behind the cone. The cone has four a handy belt shifting motion on the front side of the machine. The movement of the saddle along the bed can be controlled from the end of the latter or from the side of the saddle itself. The spindle feed is securely coupled to the carriage by friction at any point, which is found a better arrangement than the use of collars, which can only be fixed at certain positions. The yoke stay is made with the bridge portion separate from the standards, which is not only convenient for lifting away the loose bar with the work, but also as leaving a support for the free end of the bed when the yoke has to be removed to clear very large work on the table.

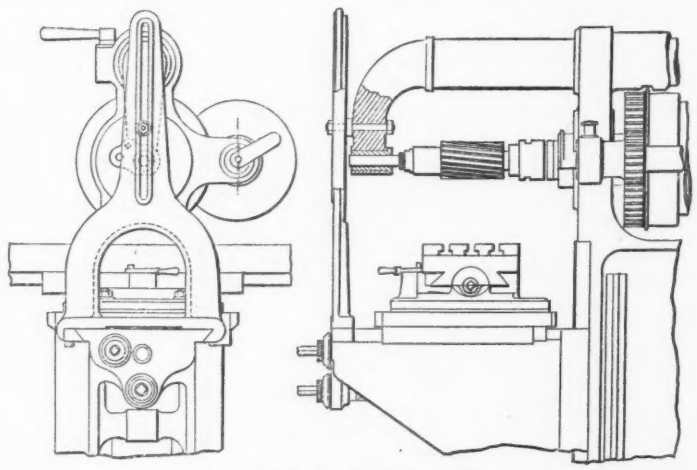


Fig. 5—MILLING MACHINE BRACE

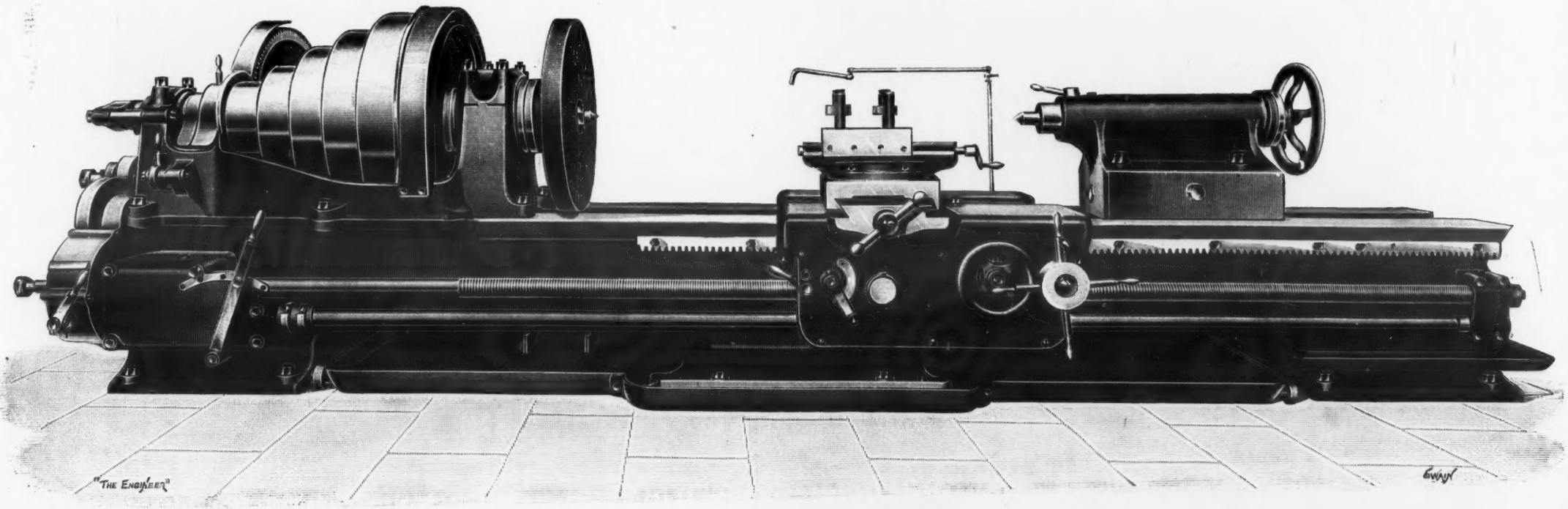
The following particulars may be useful:—The spindle traverse is 2ft. 6in.; the table traverse, 5ft. 8in.; swing over table, 5ft.; swing over bed, 6ft.; transverse motion, 3ft.; the spindle is 4½in. diameter, and sufficiently long to retain its full bearing in the socket with the longest traverse; it is provided with quick and slow hand motions in addition to the self-acting motions; the table is 3ft. 6in. wide by 4ft. 6in. long, with planed T slots and transverse movement by hand only.

A universal milling machine by Darling and Sellers is which it is impossible to make too stiff if anything except very light work is to be attempted. It may appear an astonishing statement to those who have not had the opportunity of testing its truth with the delicate instruments required, but it is a proved and recognised fact that no cantilever can be made within anything like reasonable dimensions that will not give to a certain extent under even moderate pressure. This may be proved in a length-measuring machine with sufficiently delicate indicator by putting a bar between the centres and then pressing with the hand on any unsupported part of the bed. Makers and users of milling machines have a much more practical demonstration of the fact in the unsteadiness of the cutter when supported by an overhang arm, except when the arbor is very short, and consequently various forms of bracing for the outboard bearing have been designed. The form used by Darling and Sellers, not shown in the photograph, is illustrated by Fig. 5 below. It has the advantage of excellent support on the table, fitting, as shown, into the vees; but, on the other hand, it robs the table of a few inches of horizontal adjustment. This is, however, of comparatively small consequence. The arm can be pushed back or turned up out of the way when not required, and the end is provided with a centre for light and a bushing for heavy work. The arm is 4¾in. diameter.

The driving cone takes a 3in. belt, the steps are 7in., 9in., 11in., and 13in. diameter, and the gearing five to one. The proportion is such that the spindle speeds progress in geometrical ratio; that is to say, if the second speed is double the first, then the third is double the second, and the fourth double the third, and so on. We shall return to this point later. Geometrical speed ratio is observed in all the machines made by this firm. There are, of course, eight spindle speeds obtainable for each speed of the countershaft. The spindle has hardened and ground conical necks and rims in special bronze adjustable bushes. Most of the other bearings are also hardened and ground and fitted in bronze bushes. There are eight changes of feed. For them a four-step cone and two rates of gearing, instantly adjustable by lever, are employed. In a former supplement we commented on the unnecessary complication involved by the introduction of elaborate contrivances to permit of numerous feed changes without shifting a belt. We might make the same remark here. Surely it takes no longer to move a small feed belt than it does to adjust the two or three levers which appear on certain American machines. With all respect for the ingenuity displayed in these designs we are unable to see where they are

16-INCH LATHE FOR HIGH-SPEED STEEL

DEAN SMITH, AND GRACE, LIMITED KEIGHLEY, ENGINEERS



likely to be really profitable. The fact that they are positive instead of friction drive is an independent question. The advantages of it may blind us to its defects. It is a curious commentary on American machine tool engineering that whereas only a few years ago the development of friction feeds with unlimited variation was the boast, the makers are now doing their best to do away with all friction gearing, even the harmless and necessary belt. To return to the machine under discussion. The revolutions of the cutter per inch of travel are 8, 11½, 16½, 24½, 36, 51, 73, and 109½. Here, again, a geometrical ratio is observed, the constant proportion between any two speeds being practically 1·4 to 1. A reversing motion for the traverse is operated from the front of the slide, and there are, it is scarcely necessary to say, automatic stops to vertical, longitudinal, transverse, and angular traverse, whilst adjustable dials, reading in thousandths, are fitted to the vertical, longitudinal, and transverse screws. The vertical slide has a range of 18in.; its screw is fitted with ball thrust bearing to facilitate manipulation; the table is capable of adjustment to and from the column with a range of 8¼in. when the outboard support is not used; it can swivel on the slide and be held down in any desired position by four bolts working in a complete circular slot. Its working surface is 48in. by 9½in., and it has a trough for lubricant.

A useful adjunct, which is very generally supplied with this type of machine, is a vertical horizontal and angular milling head. It can be firmly clamped at any angle to a large annular seating surrounding the main spindle bearing. It is shown in position in Fig. 3. An additional spindle for rack-cutting is provided.

We illustrate yet another machine by Darling and Sellers. It is a vertical spindle milling and drilling machine of the slotting machine type—see Fig. 4. The leading features of this machine are the neat and compact drive, by steel machine-cut bevel gear inside the travelling head or "ram," and the handy attachment for self-acting drilling, which latter feature, in combination with the accurately-spaced dividing notches in the rim of the circular table, renders it suitable for a great variety of engineering work.

Automatic feeds, longitudinal, transverse, and circular, are all provided, and each is reversible. Every feed, moreover, is furnished with positive, quick-acting knockoff, a very serviceable provision, especially when engaged in rotary work, where a complete revolution of the "work" is impossible.

The circular table is troughed, with an annular reservoir below it, and full lubricating system, with rotary pump, is provided. When desired, a copying or profiling attachment can be fitted, and provision is made on the column for the reception of a bottom stay for the cutter arbor.

The maximum distance from spindle end to the top of the table is 1ft. 1in.; the minimum distance 4in.; the distance from the centre of the spindle to the column is 1ft. 6in.; the longitudinal traverse is 1ft. 5in.; the transverse traverse, 2ft. 4in.; and the vertical traverse, 9in.; the head is balanced by a weight inside the column, and can be moved by hand or power, the power movement having four changes of speed for drilling. The ratio of the bevel wheels for the drive is 2 to 3. The cone has four speeds for 3in. belt, 7in., 9in., 11in., and 13in. diameter, and a back gear with ratio of 5 to 1. The table is 2ft. diameter; the rates of traverse are 8, 11, 15½, 20, 28, 39, 50, 67, and 97 revolutions of the spindle per inch of movement. The circular and transverse traverse may be effected automatically; the table has twenty-four accurately-spaced notches in its rim.

The Yorkshire makers, and particularly those of Keighley, have taken time by the forelock. They have lost no time in meeting the requirements for a heavier and more powerful machine to employ "high speed" steel. When it is remembered that the possibility of cutting steel at speeds up to even 150ft. per minute became generally known only as recently as the last Paris Exhibition, it will be admitted that the fact that several special lathes have already passed the experimental stage is a matter for which the Keighley makers deserve the greatest commendation.

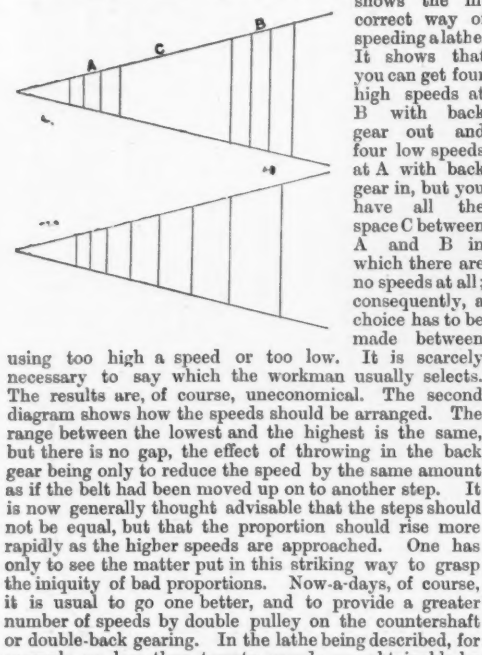
We have only within the last few weeks—THE ENGINEER, April 11th—illustrated and described a lathe made by Darling and Sellers which is powerful enough to take any cut that the tool and the work will stand. It is, as we showed by sections at the time, provided with a very remarkable bed, which not only affords excellent support for the rest, but permits of a very neat arrangement of the lead screw. The feed is changeable by a train and sliding key, but a short belt is introduced, a plan which we commended. There is undoubtedly a trend in favour of positive feeds at present, due partly to a revulsion against friction feeds, which are not infrequently a source of trouble. There is, of course, much to be said in favour of positive feeds, but we are not persuaded that in the case of machines which are intended to work up to the limit of resistance of the cutting tool that it is not a very wise course to provide a weak spot which may give way before any serious damage is done. It is, of course, possible to make all the parts so strong that nothing in the machine is likely to break, but in that case, unless the main belt slips, it means that the chuck gives way, generally a very undesirable occurrence. It seems to us, therefore, that Darling and Sellers have done wisely in providing a "safety valve" in the form of a feed belt. For further particulars of that interesting machine we must refer our readers back to the number already mentioned. We now wish to describe a large high-speed lathe made by another Keighley firm—Dean Smith, and Grace. The makers have very kindly given us tracings of this fine tool, and they are reproduced as a two-page drawing in the present supplement. Above will be found also an engraving showing the general appearance of the machine.

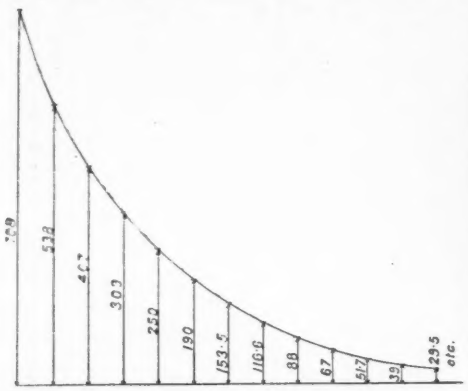
DEAN, SMITH AND GRACE, LIMITED.

This lathe, it will be at once seen from the drawings and wood-cut, is a larger machine than that referred to above. It is—we believe we are right in saying—the largest lathe specially designed for high-speed steel that has yet been completed in this country. The height of the centres is only 16in., but the proportions of the headstock and the general strength of the lathe would suit it for a nominally larger machine. The bed is 2ft. 6in. wide over the vees, and it is 1ft. 6in. deep. Under it is a cast iron trough, which is mounted on rollers or castors, so that it may be pulled out for clearing the turnings away, and so on. This, we believe, is exceptional, and considering the small height of the bed above the floor, it would appear to be a good point.

The fast headstock is, as we have said, unusually powerful. The spindle, which it is scarcely necessary to say is of steel, ground truly circular, runs in parallel gun-metal bearings. The front brass is 9in. diameter by 12in. long. Further details of it will be gathered from the drawing. The cone has five steps wide enough to take a 6in. belt, the smallest 12in. and the largest 34in. in diameter. There is also back gearing of high ratio, namely, 13·8 to 1, so that there is full provision for the maximum cut. We may mention here that the guarantee for this lathe is a cut 1in. deep at 8 per inch traverse at 50ft. per minute. Like Darling and Sellers, Dean, Smith and Grace call attention to the fact that there is a full range of speeds. This is a point which used to be neglected, particularly in large lathes, but if economical work is to be done it is essential

that there should be no gaps in the sequence of speeds. Some years ago a tool maker of great experience put the matter very clearly to us in diagrammatic form. His sketch may be worth reproducing. The upper diagram shows the incorrect way of speeding a lathe. It shows that you can get four high speeds at B with back gear out and four low speeds at A with back gear in, but you have all the space C between A and B in which there are no speeds at all; consequently, a choice has to be made between using too high a speed or too low. It is scarcely necessary to say which the workman usually selects. The results are, of course, uneconomical. The second diagram shows how the speeds should be arranged. The range between the lowest and the highest is the same, but there is no gap, the effect of throwing in the back gear being only to reduce the speed by the same amount as if the belt had been moved up on to another step. It is now generally thought advisable that the steps should not be equal, but that the proportion should rise more rapidly as the higher speeds are approached. One has only to see the matter put in this striking way to grasp the iniquity of bad proportions. Now-a-days, of course, it is usual to go one better, and to provide a greater number of speeds by double pulley on the countershaft or double-back gearing. In the lathe being described, for example, no less than twenty speeds are obtainable by means of the long step cone, the back gear, and the double countershaft. They are 4·8, 6·3, 8·4, 11·4, 13·6, 18, 22·4, 29·5, 30, 51·7, 67, 88, 116·6, 153·5, 190, 250, 309, 407, 538, and 708; these numbers, it will be seen, have a





pretty constant ratio of 1 to 1·3 odd to each other. The annexed diagram of the higher speeds shows the relation to each other. A reversing motion is placed upon the headstock.

The loose headstock is made to similar heavy proportions. The spindle is 5in. diameter, and is ground truly cylindrical. It has lateral movement, with marked

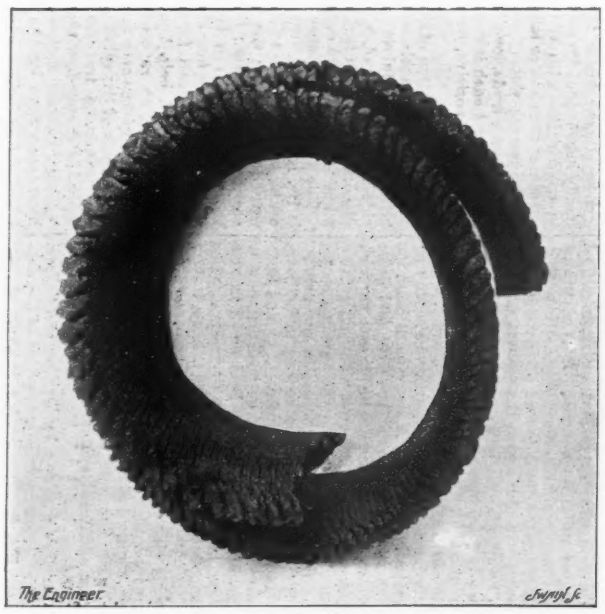
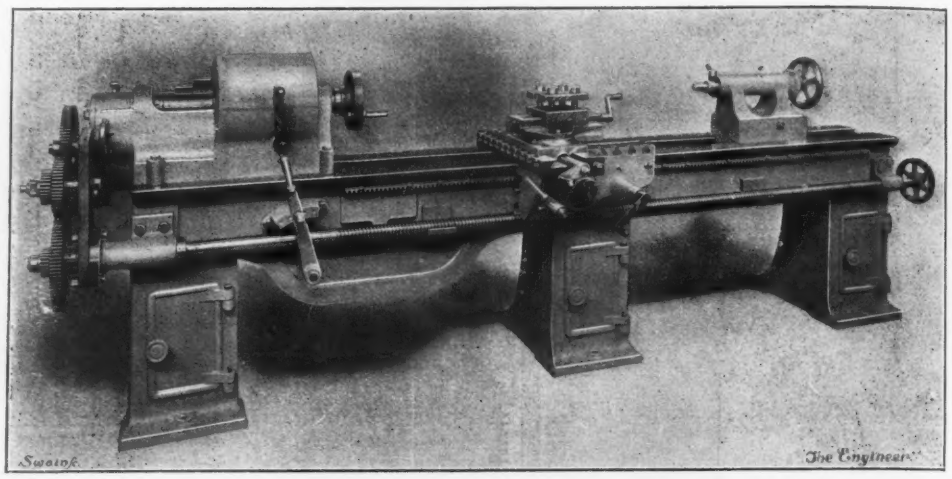


Fig. 6—TURNING FROM 16in. LATHE

divisions for taper turning. The drawing of the saddle is more instructive than a verbal description. The large worm wheel provides the powerful feed required. It is of phosphor bronze, carefully hobbed to avoid shake. Notice should be taken of the manner in which the rack pinion is supported. It is turned truly, and fits

8½-INCH LATHE WITH SPECIAL HEADSTOCK

MILEY'S MACHINE TOOL CO., LIMITED, KEIGHLEY, ENGINEERS



exactly a bored cylinder, out of which the top part is cut to permit of the pinion teeth meshing with the rack. Any chance of the pinion tending to spring away from the rack under heavy cuts is thus amply provided against. The thrust is taken on hardened and ground steel tail pieces. The compound rest is graduated for taper turning.

The makers have adopted a positive feed, about the advisability of which, as we have already said, we are in some doubt. The gearing is contained in a box in front

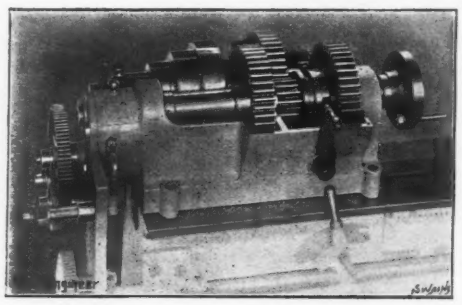


Fig. 7—MILEY'S SPECIAL HEADSTOCK

of the headstock, and the change is readily made by handle. The feeds are six in number, namely, 4, 8, 12, 16, 24, and 48 per inch.

All the gearing is, of course, machine cut from the solid, and the pinions are cut steel, solid with their shafts.

Some tests have recently been made with this powerful lathe in the makers' shops, who have kindly given us some particulars. We reproduce to exact size, as likely to interest those of our readers who have not seen work of this size done at such high speeds, part of a turning cut at 56ft. per minute. Curious markings, which it is not very easy to explain, may be seen on the original, but do not appear very clearly in the reproduction. The regular way in which the turning fractures round the edge will be observed. The depth of the cut was ¾in., the feed 6 per inch. It was taken on a mild steel shaft 10½in. original diameter, and no lubricant was used.

The weight of metal removed per hour as represented by this cut amounts to about 1600 lb. The makers inform us that they have on this 16in. lathe removed as much as 1875 lb. per hour with one tool. From the same shaft, 10½in. diameter, a cut ⅜in. deep and a feed of ¼in. at a speed of 56ft. per minute removed about 1000 lb. per hour, and at 80ft. per minute, 8 per inch, ⅛ depth of cut, about 1800 lb. of metal comes off per hour.

Higher speeds than this, but, of course, with smaller cuts, are possible; but a good commercial speed is about 80ft. per minute. The makers inform us, however, that they are confident that, when fuller tests can be made, the lathe will be able to better these results. They judge from a 12in. lathe in their shop, which has only about one-third of the belt power of the machine illustrated. With this lathe a cut ½in. deep, 6 per inch traverse, has been taken at 56ft. per minute, which is no less than some of the cuts recorded above. It is, therefore, fair to assume that the 16in. lathe has not yet been tried to its full capacity.

The drawings with which the makers have been good enough to supply us are reproduced to such a large scale that they will be readily understood. The apron, shown in detail, differs slightly from that shown in the engraving on page iii. and in the elevation. It will be observed that there are two levers, A and B, and two cross screws, either or both of which can be put in gear as shown, by raising the corresponding lever. This is the arrangement adopted when two slide rests are used, back and front, as in turning up crank shafts, &c. It permits of both rests being manipulated from the front of the apron. The end thrust is taken on a hardened and ground steel tail piece.

MILEY'S MACHINE TOOL CO., LIMITED.

It will be convenient to refer here also to yet another lathe for special steel made in Keighley. We say lathe, but it would be more correct to say headstock only, because the makers, Miley's Machine Tool Company, Limited, have designed a special head which can be fitted to any existing lathe and give it the necessary driving power to use the new steel to advantage. Provided the rest of the machine is also powerful enough, this should be a satisfactory arrangement. The design of the gear is good, and it is neatly enclosed. The object, of course, is to obtain a higher belt speed, but without the necessity of employing a large cone pulley, as Darling and Sellers and Dean, Smith and Grace do. It is, of course, obvious that a larger pulley means, for the same centres, an alteration in the bed, and this it is the makers desire to avoid. How this end is arrived at will be quite clear from the view of the headstock with the cover removed—Fig. 7. The belt cone, it will be observed, is put on the excentric shaft at the back, which is used for putting in the back gear. On the end of this shaft is keyed a raw hide pinion which meshes with a wheel on the spindle. By this means the belt speed for the same sized lathe is raised about three and a-half times from what it is in the maker's normal type. It will be noticed that this is simply doing on a small scale what is done in

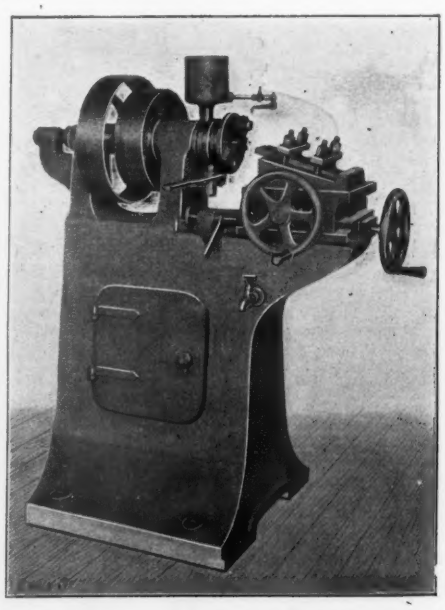


Fig. 8—WILKINSON'S NUT TURNING MACHINE

nearly all heavy shafting lathes, where the driving cone is rarely on a line with the spindle. It is obviously open to the disadvantage that no speed is available without transmission through gearing, but in that it is applicable to existing lathe beds should prove useful. It is unnecessary to say that all the gearing is machine cut. On

RACK-CUTTING, BORING, AND MILLING MACHINES

G. WILKINSON AND SONS, KEIGHLEY, ENGINEERS

(For description see page vi.)

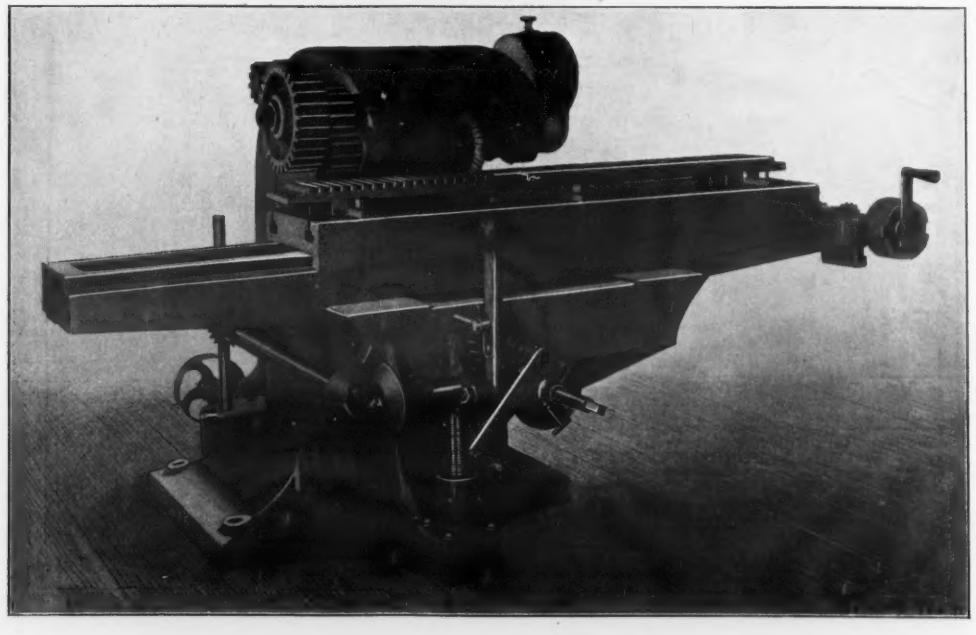


Fig. 9—HEAVY RACK-CUTTING MACHINE

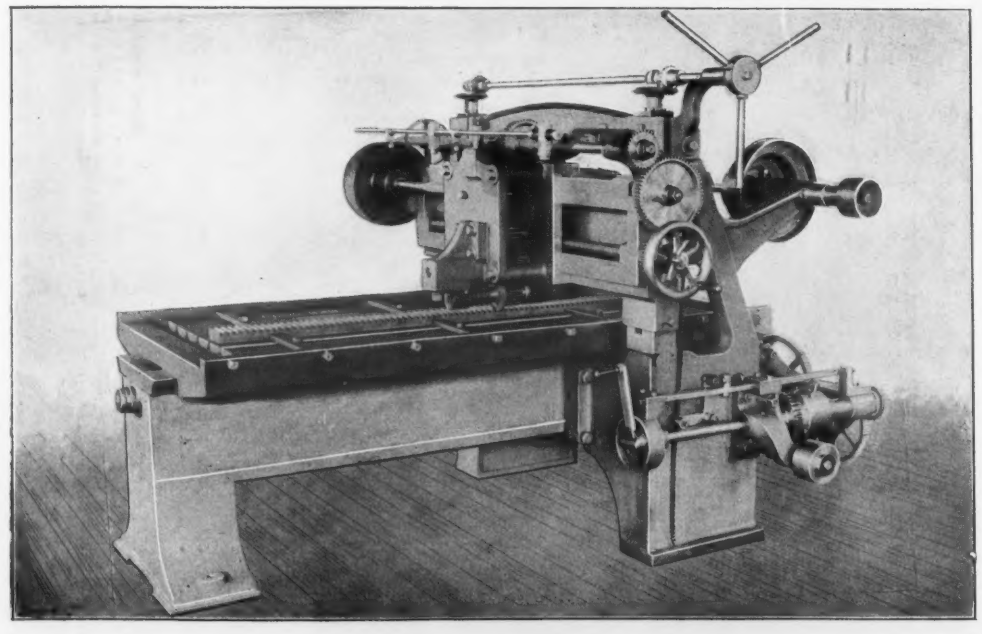


Fig. 10—HORIZONTAL RACK-CUTTING MACHINE

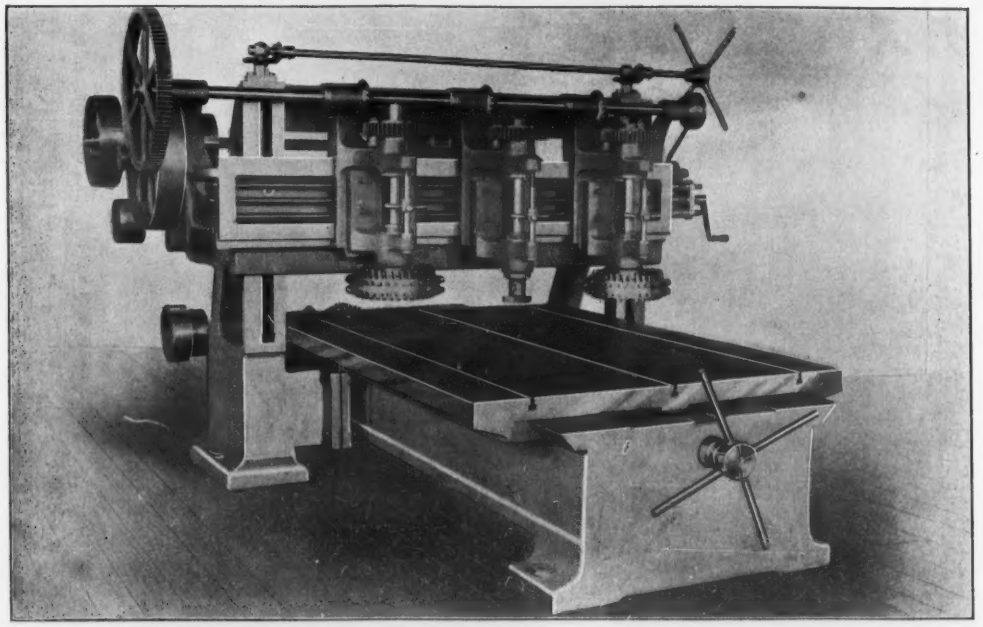


Fig. 11—THREE-HEAD SURFACE MILLING MACHINE

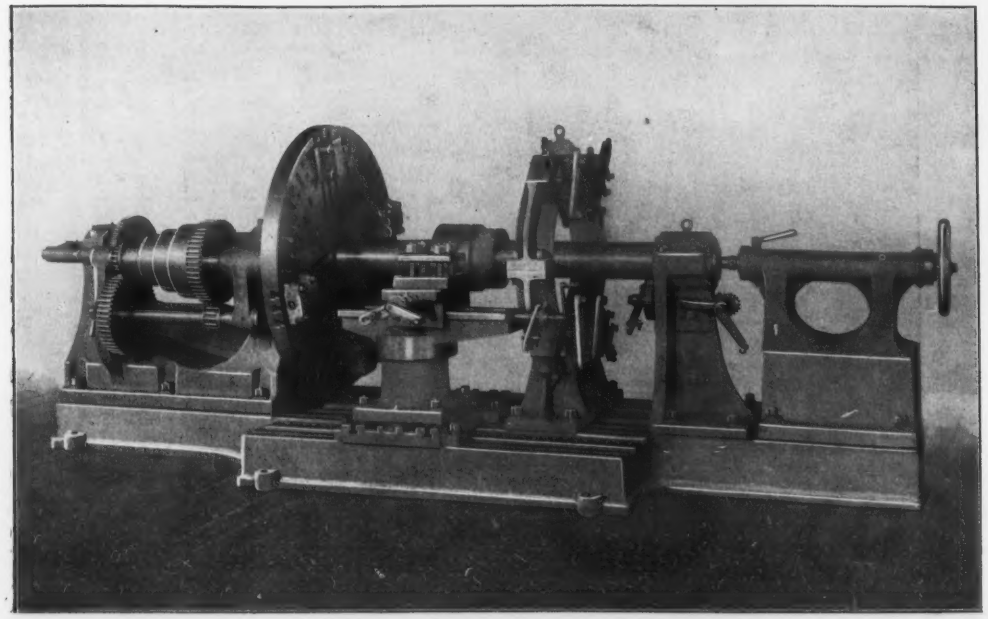
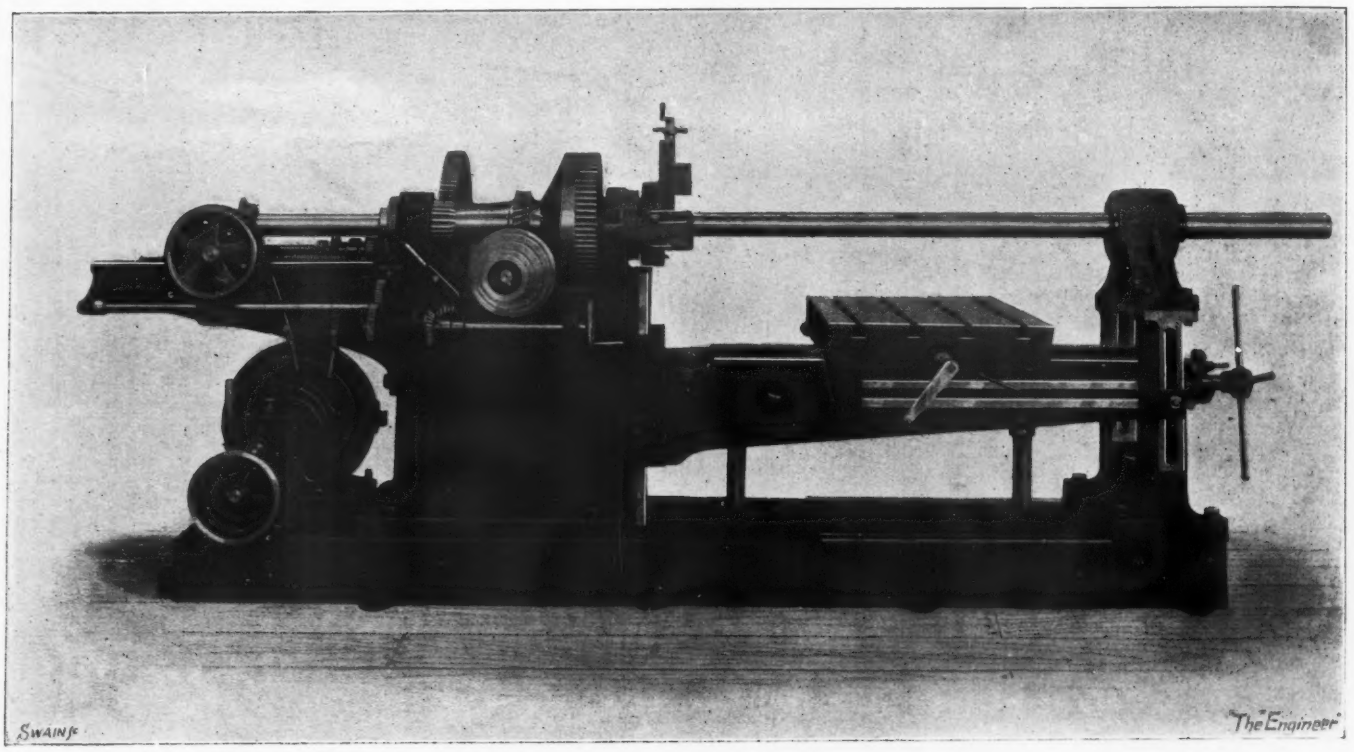


Fig. 12—CYLINDER LATHE

ELECTRICALLY DRIVEN BORING MACHINE

W. ASQUITH, HALIFAX, ENGINEER



page iv. an 8½in. centre lathe fitted in this manner is shown. We are informed that four other sizes up to 16in. centres are made to the same design. The headstock has a neat and compact appearance.

G. WILKINSON AND SONS.

Several machines by G. Wilkinson and Sons, of Keighley, are illustrated on page v., and another, an ingenious nut-turning machine, on page iv. We may deal with this first. The saddle carries tools for facing and chamfering. It is worked by two hand wheels, and stops are provided for each direction. There are two pulleys, driven by one on the overhead shaft; the larger of the two is on the spindle, the smaller on a sleeve. They both run continuously in the same direction, but by sliding a clutch forward by means of the lever shown, two stops, driven by the smaller and, of course, faster running pulley, engage with the nut and unscrew it. The spindle is, therefore, constantly running in the same direction, and no time is lost in reversing. A boy works the machine.

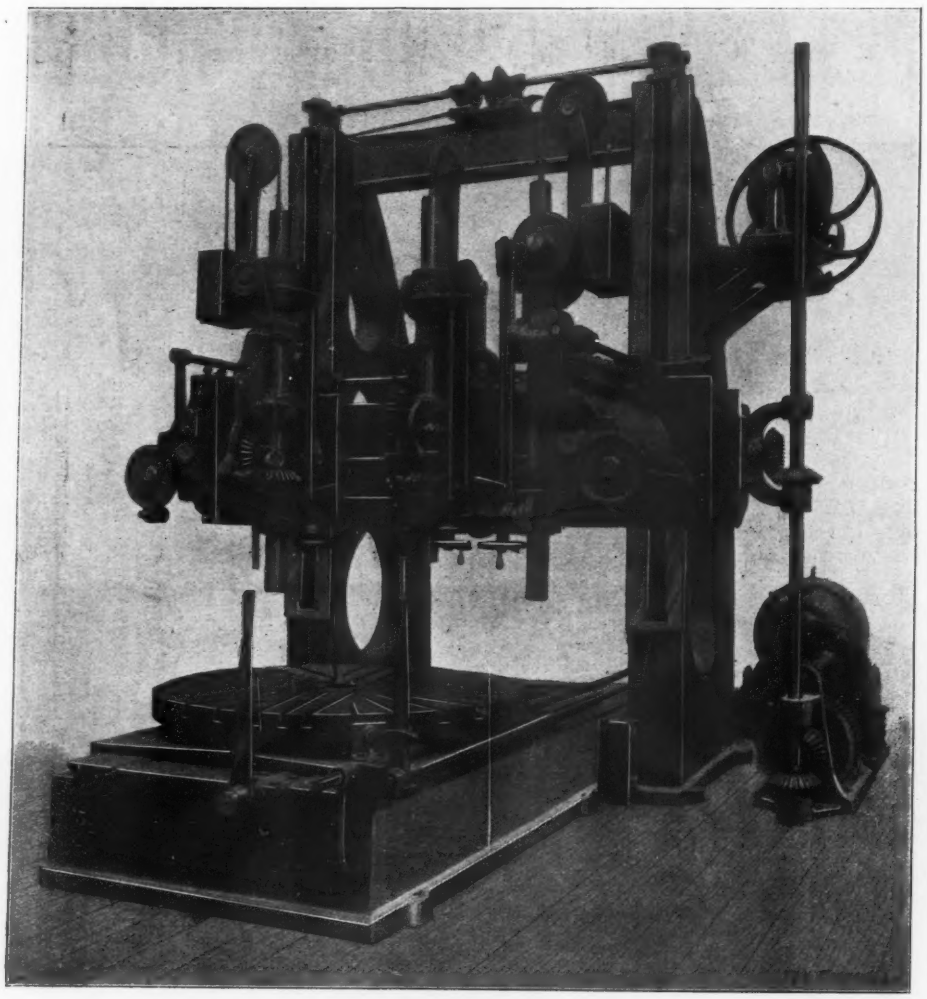


Fig. 13—THREE-SPINDLE DRILLING MACHINE, J. BUTLER AND CO.

Two of the machines illustrated on page v. are rack cutters, that shown in Fig. 9 being of quite a new type and exceptionally powerful. The depth of the casting carrying the cutter spindle, the great breadth of the table, and the general substantiality of the machine may be noticed. It will cut racks up to 2in. pitch, 8in. wide by 4ft. long, and it is very strongly geared. The drive is by steel worm and phosphor bronze wheel. The table is 4ft. 6in. long by 1ft. wide; it has automatic feed and stop motion, and is adjustable vertically and longitudinally by hand. It is provided with an accurate screw for dividing. Some machines have been made, we are informed, with this screw cut to metric measures. It has ⊥-slots in its upper surface. The total weight of the machine is 33½ cwt.

The machine shown in Fig. 10 is of the planer type, and is an older design. It was got out originally for cutting the racks for printing machines. It will, we are informed, cut racks of 1¼in. out of the solid at the rate of 1in. per minute at the full depth. The maximum breadth of cut is 36in., and the length of rack that can be cut is 6ft. 6in. The bed on which the table slides is 8ft. 6in. long; the table is 7ft. long, and has flanges on its outer edges provided with cramping screws, so that the work can be easily and quickly set. The cross slide has a vertical adjustment of 9in. on the side standards, and the saddle or cutter carriage has a variable self-acting feed of 40in., and is also fitted with reversing gear, and has a quick return motion after having travelled through the cut. The number of turns of the dividing handle required can be regulated by a chain attached to the carriage, which releases the dividing gear at the end of the return traverse. When the necessary divisions are given, the cutter again cuts into the rack. The dividing handle shaft is connected by change wheels to an accurately cut screw for moving the table, and by which any pitch of rack up to 1¼in. may be divided. The machine is entirely automatic; after the work has been fixed and the machine set in motion, the attention of the attendant is no longer required until it has completed the work upon which it is engaged.

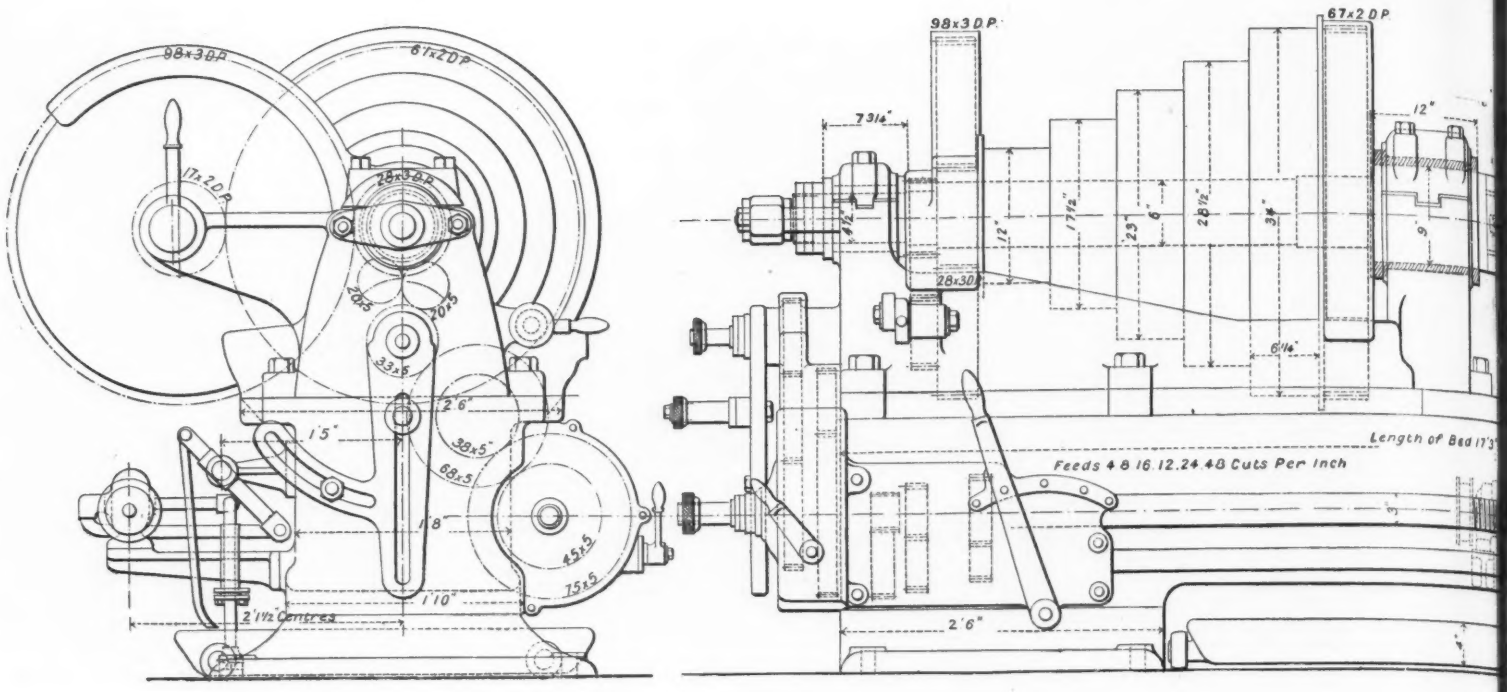
The machine illustrated by Fig. 11 is a three-headed surface milling machine, and was designed for machining the surfaces of cotton spinning frame ends. The table has planed ⊥-slots for bolts, and is adjustable in either direction by power. It has variable automatic feed motion by a screw down the centre of the bed, which is operated by double clutch motion at one end of the bed, and a lever is placed at the front side of the machine, where it is easily accessible, for putting it into gear; by pulling the clutch out of gear with the feed motion, and putting it into gear with the opposite clutch, it gives a return motion 120 times the speed of traverse. The table is stationary when the clutch is in its middle position, and is then adjustable by the star wheel. The cross slide is adjustable vertically on the standards.

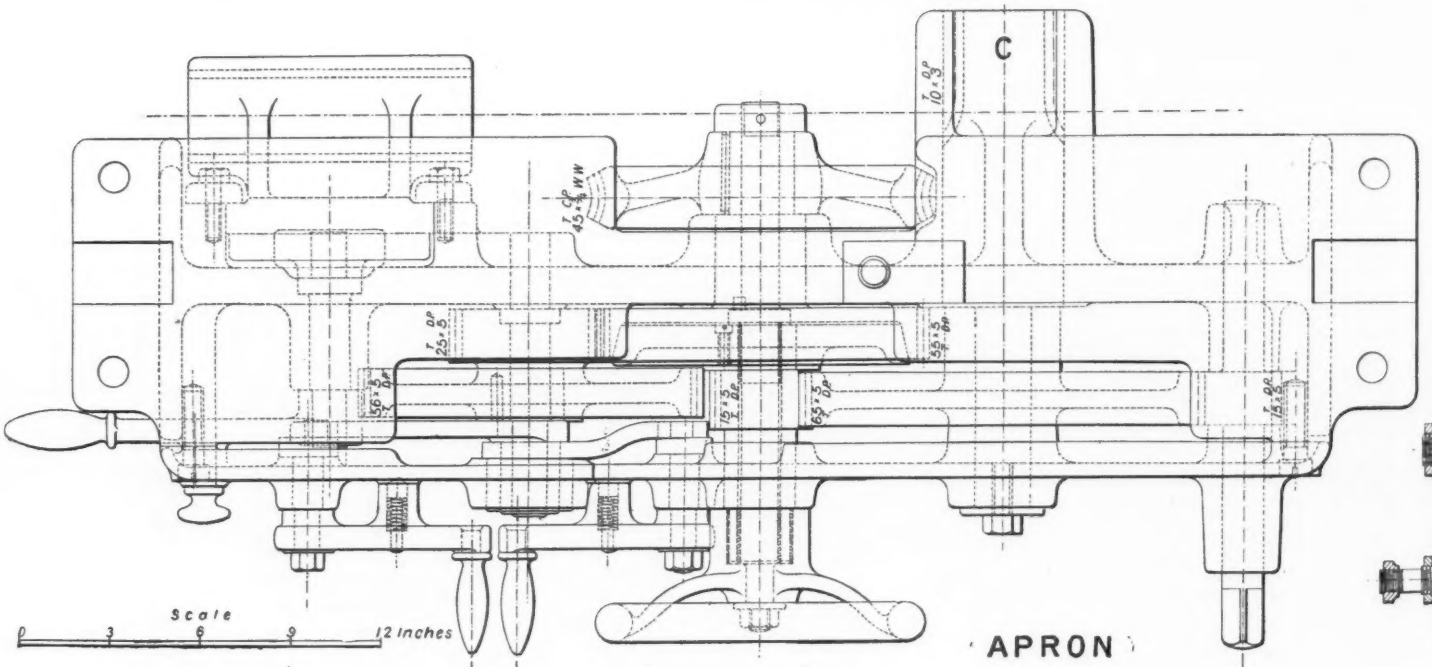
The cutter heads have steel spindles; they will mill longitudinally and transversely automatically. The outside heads have each a disc cutter with twenty-four inserted tools; the middle head has a 5in. diameter cutter by 1in. wide for flat surface and edge-cutting, so that an L seating may be milled. The tool discs can be readily screwed off to admit of changing the cutter when desired. The following is a list of the principal dimensions:—

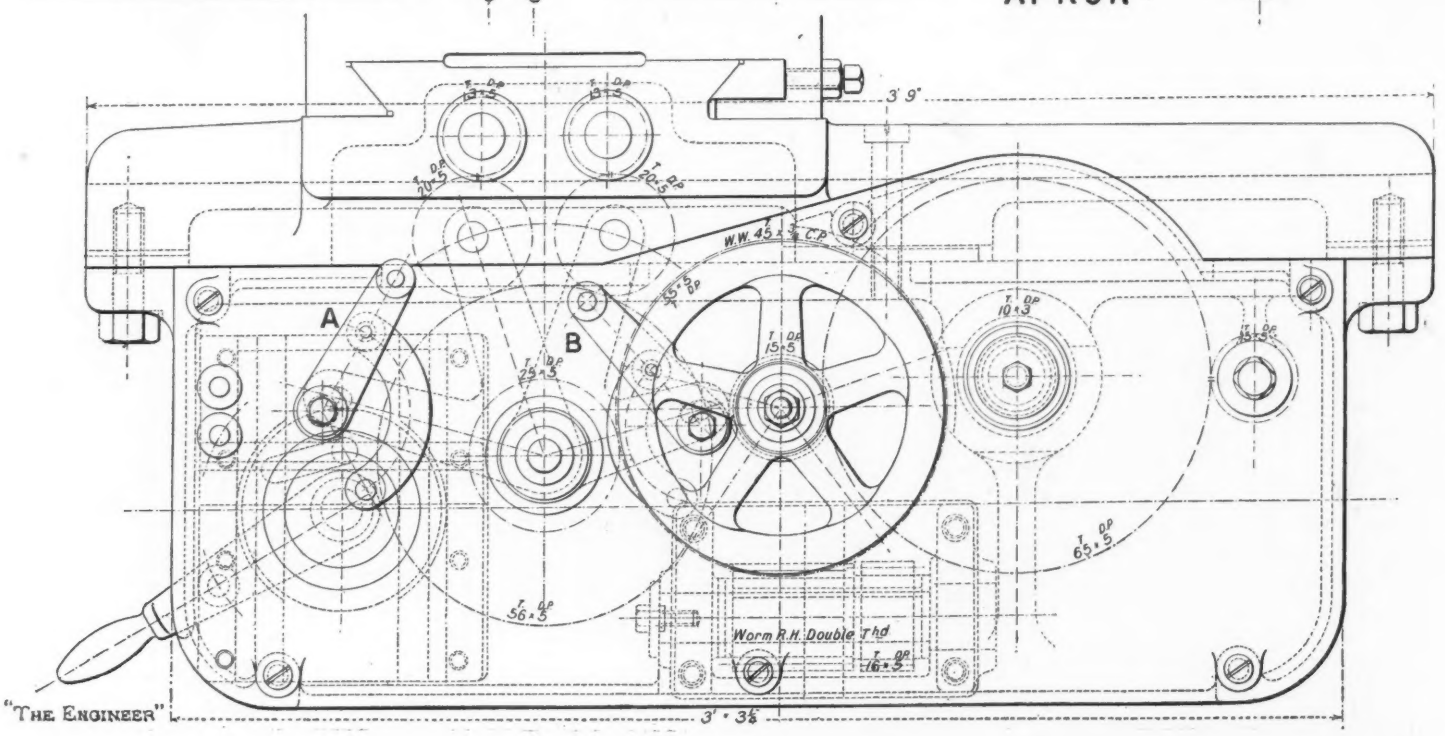
	ft.	in.
Length of bed	10	0
Depth of bed	1	5
Width of face of bed	3	
Length of table	7	
Width of table	5	0
Will mill work in length	8	0
Will mill work in width	5	
Will mill work in height	3	4
Diameter of steel cutter spindles	0	2½
Diameter of cutter heads	1	0

16-INCH LATHE FO HI

DEAN SMITH, AND GRACE, TED,



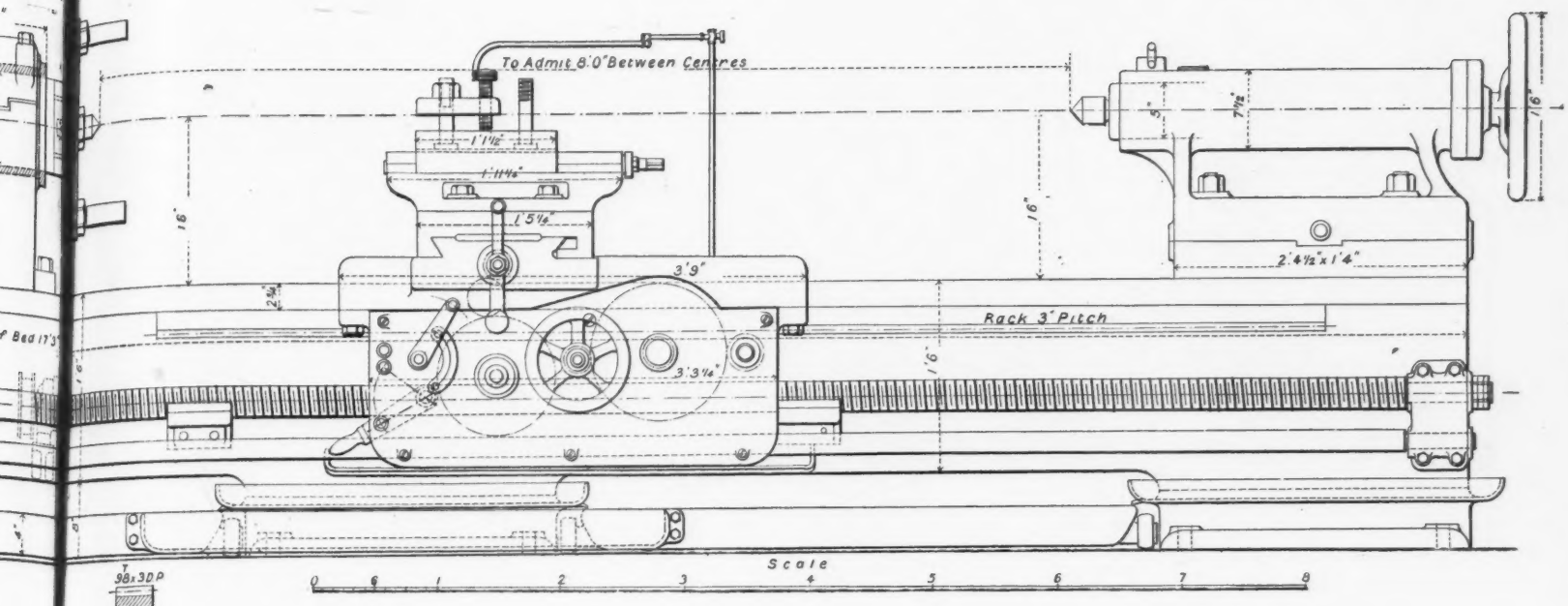


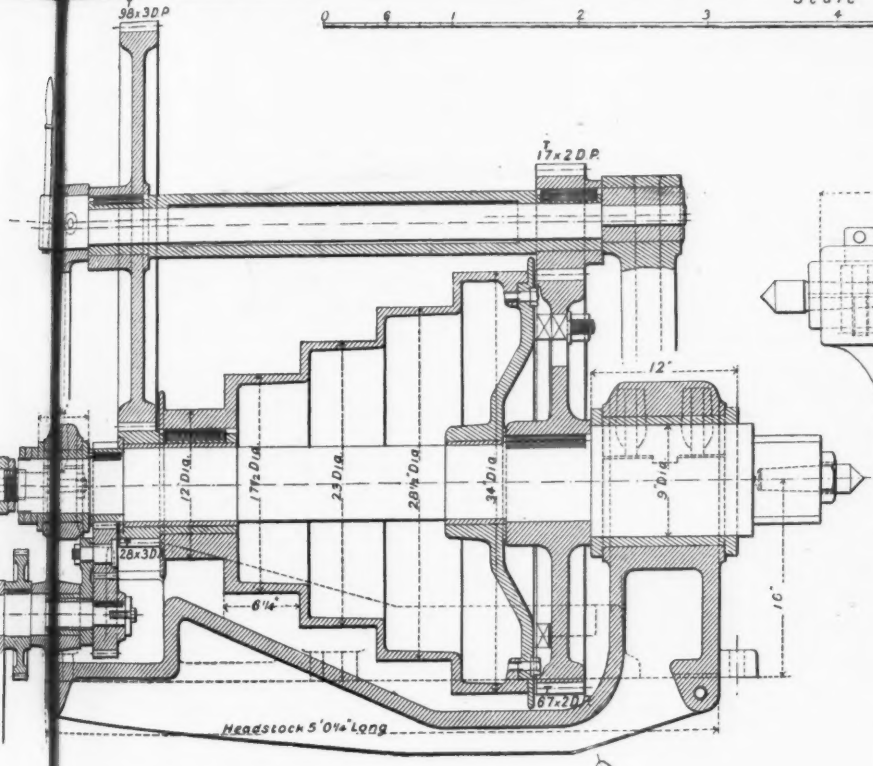


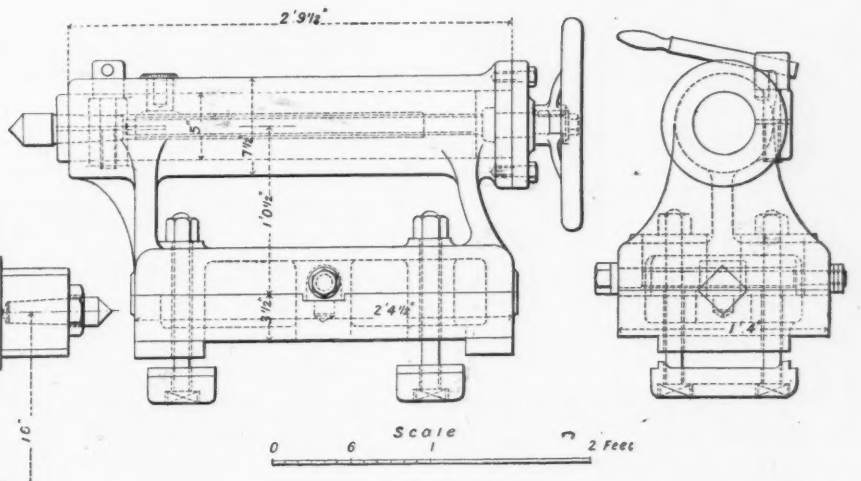
"THE ENGINEER"

FO HIGH-SPEED STEEL

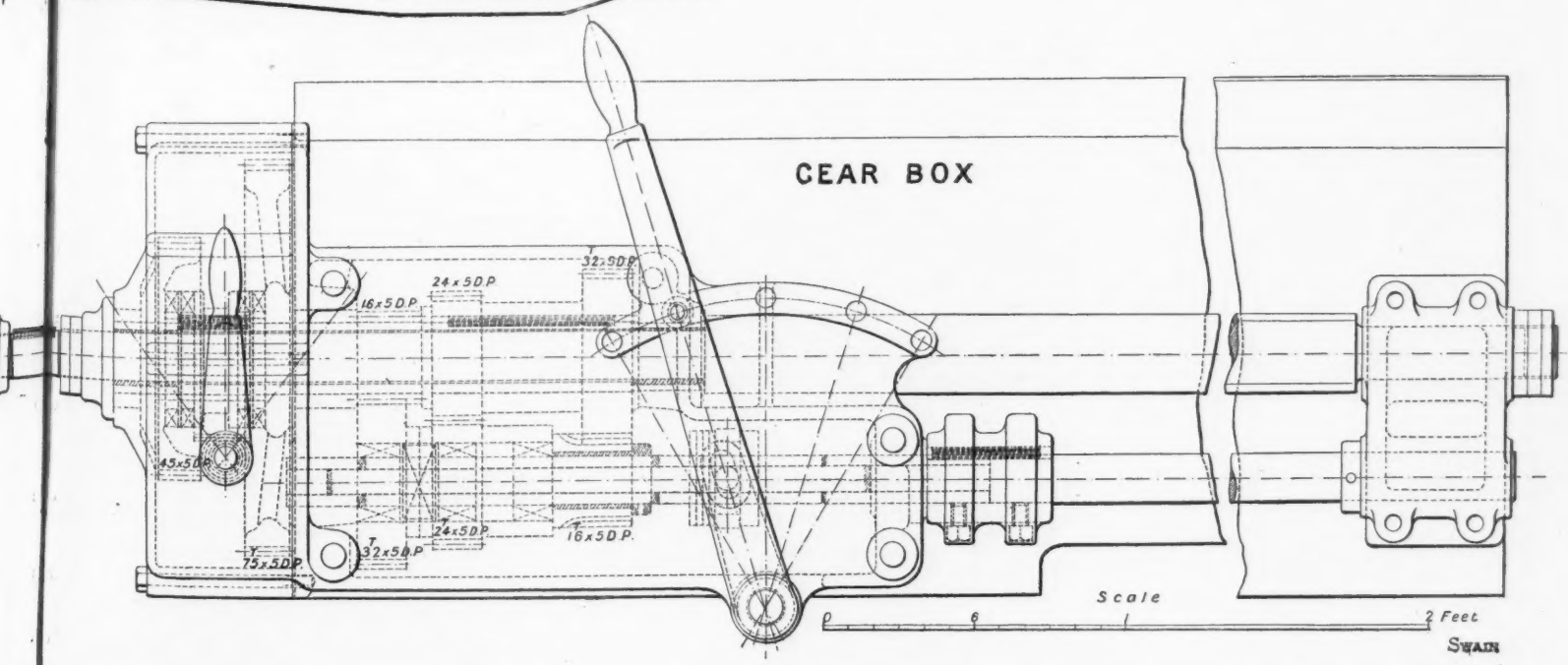
D GRACE, TED, KEIGHLEY, ENGINEERS







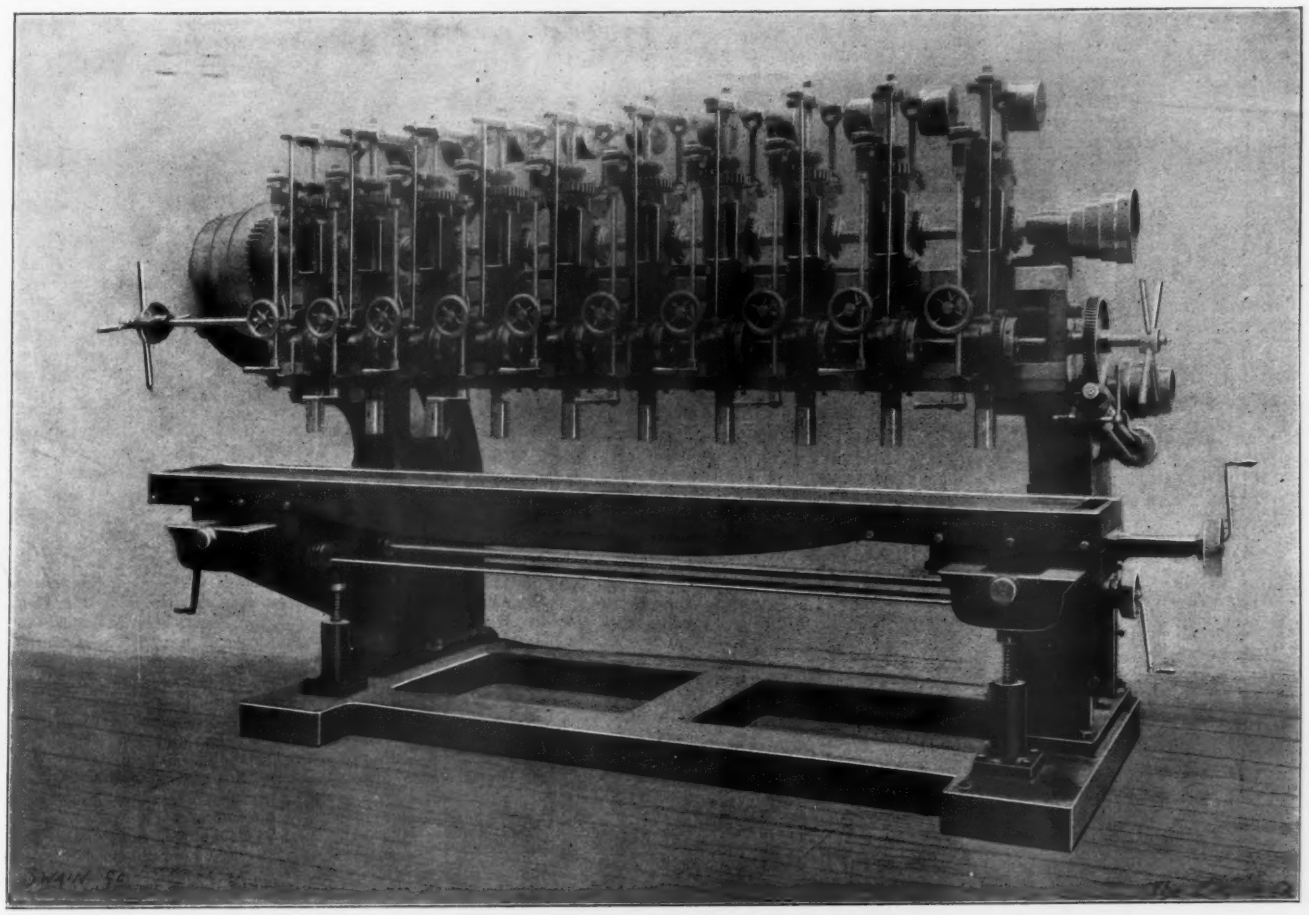
GEAR BOX



SWAIN

TEN-SPINDLE DRILLING MACHINE

J. BUTLER AND CO., HALIFAX, ENGINEERS



Driving cones, four speeds	18½in., 15½in., 12½in., and 9½in. × 4½in.
Countershaft pulleys ...	20in. × 4½in.
Speed of pulleys	160 revolutions
Weight	8½ tons
Space occupied	10ft. × 14ft. 3in. × 8ft. 9in. high

The lathe shown in Fig. 12 is specially designed for boring and turning cylinders, cylinder liners, and similar work. The headstock has single and treble gearing, and drives a face plate with an internal wheel on the back. A strong cast iron spindle with a solid flange fits into a recess in the face plate. A compound slide rest is mounted on a pillar in the manner shown. It is self-acting, being worked by "picking" motion giving three "picks" to one revolution of spindle. The boring head feeds automatically along the boring bar by a screw let into the bar, and worked by wheels and "picking" motion at the loose head end of the bar, with a feed varying from $\frac{1}{16}$in. to $\frac{1}{4}$in., and can be returned at a quick speed by hand; a loose headstock and centre are provided to bring up and adjust the bar endways. Special holders for supporting the outer end of the work are also shown. The principal dimensions are :—

Height of centres	33in.
Foundation plate	16ft. 8in. long, 4ft. 10in. in widest part, 10in. deep
Face plate	5ft. diameter
Spindle ...	11½in. and 12in. front neck; 9in. and 10in. back neck
Driving cone, 4 speeds,	16½in., 14in., 11½in., and 9in. diam., 4½in. wide
Boring bar	8in. diameter by 7ft. 6in. long
Weight	9½ tons

W. ASQUITH.

We illustrate on page vi. one tool made by Mr. W. Asquith, of Halifax. It is a powerful electrically-driven boring machine, recently completed for H.M. Government Dockyard at Bermuda. It has been designed with special regard to accuracy, so that any series of parallel holes may be bored truly cylindrical without any further adjustment after the first. With this object in view, the end support for the bar, instead of being, as it is frequently, merely a bushed hole in which the bar runs, consists of a large conical bush which revolves in a suitable bearing, the bar merely sliding longitudinally through it. This is, of course, practically the same arrangement that is used universally in good drilling machines. The bush being ground truly cylindrical to begin with, the amount of wear is so slight that it remains perfectly true for a very long time; on the other hand, and for the same reason the bar does not get worn out of truth and elliptical, as happens when it revolves in the bushing. There can, therefore, be no question about the advisability of transferring the greatest movement to a bearing capable of easy and accurate adjustment.

The general arrangement of the machine is well shown in the engraving. The motor is mounted on an extension of the bed under the tail bracket, and drives a four-step cone through a change gear-box. The belt is not on in the machine as engraved. The upper cone drives a worm wheel on a sleeve taking the place of the ordinary cone, and this, either direct or through back gearing, drives the boring spindle. There are in all sixteen spindle speeds, with six rates of feed, all properly graded. The machine is fitted with a steel spindle 8½in. diameter, having a hand and variable and self-acting traverse of 2ft. 6in., which can be quickly extended to 4ft. by getting a fresh hold of the spindle. The length admitted between the end of the spindle and the steady standard is 5ft. 11in., but the end brace can be removed to admit longer articles. The table has compound motions, and is fitted with hand and variable self-acting feed motions, both longitudinally and transversely, and can be raised and lowered by power. A portable circular table can be mounted on it to enable parts to be machined at various angles without re-setting. The gears throughout are machine cut, and the racks and pinions are of hammered steel. We are informed that the same type of machine is made in various sizes and for belt as well as for electric driving. The uses of this kind of machine are not limited to boring and facing. There is a good deal of milling which may be done advantageously on a tool of this type; and by having a suitable rest for attachment to the table it may be used not uneconomically as a face plate or chucking lathe.

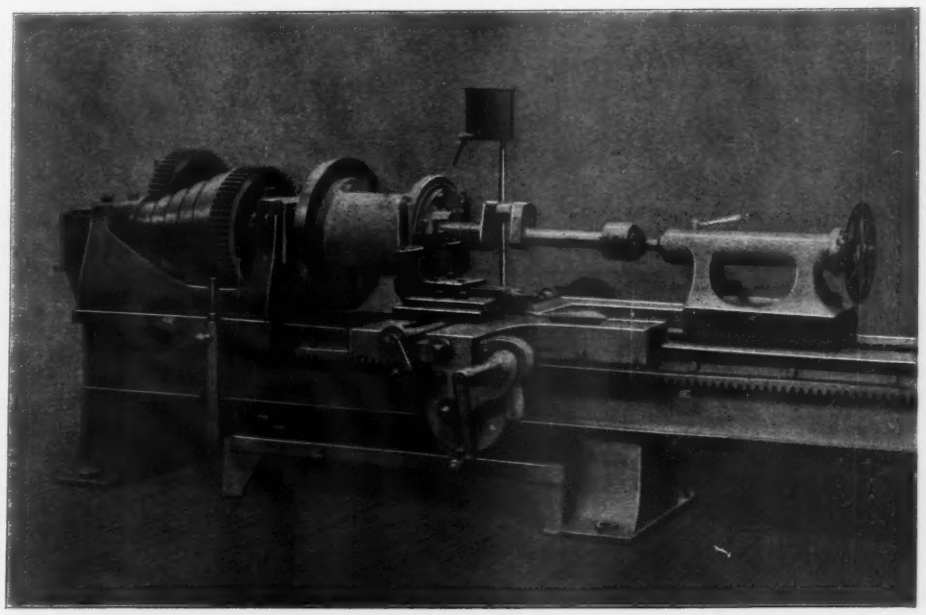


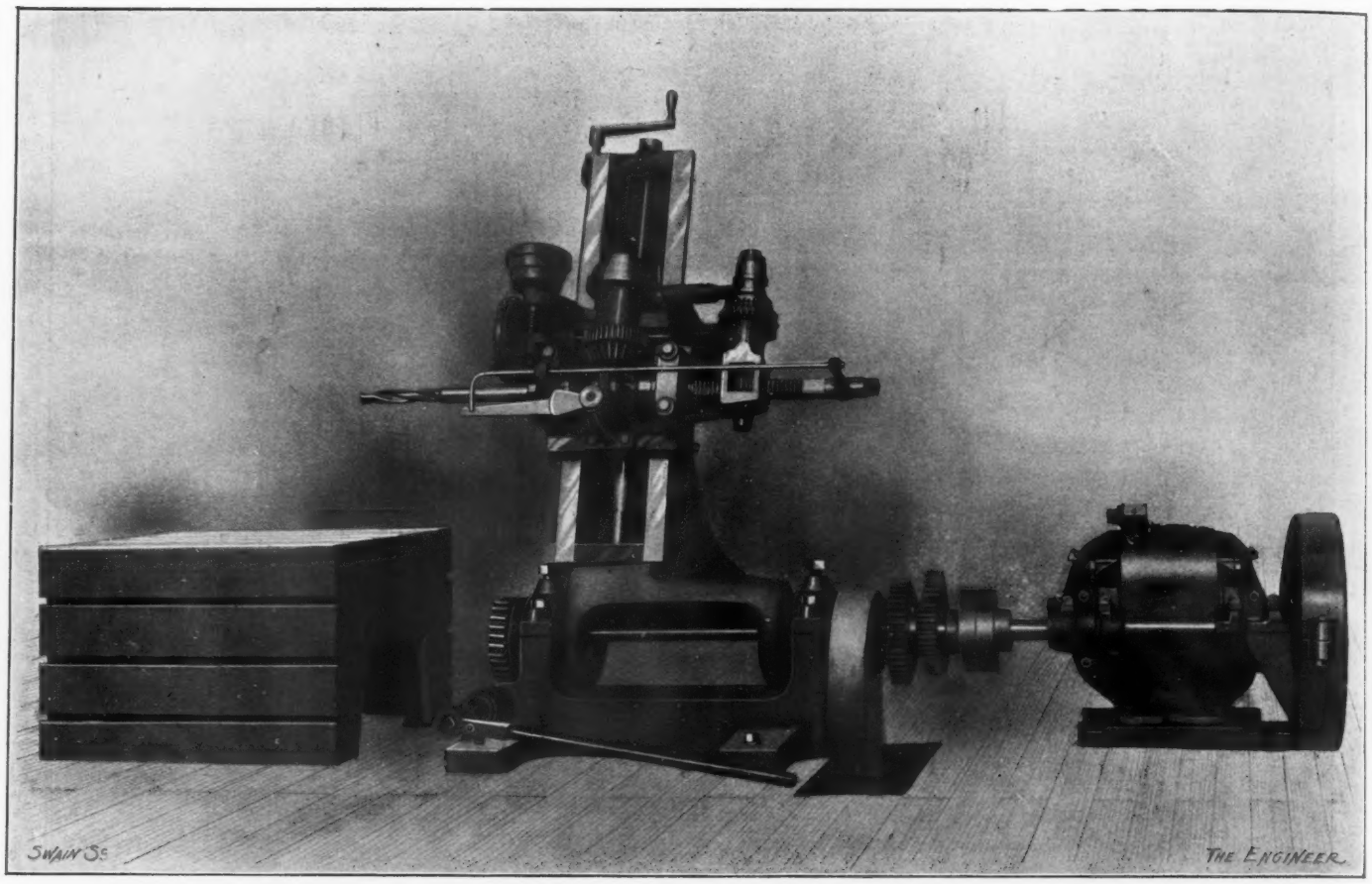
Fig. 14—CRANK TURNING LATHE, J. BUTLER AND CO.

J. BUTLER AND CO.

The principal machines by J. Butler and Co., of Halifax, which we illustrate, are two drills of special design. Fig. 13, page vi., is a large three-spindle drilling and tapping machine of a rather unusual type. It has been got out specially for boring, drilling, tapping, and inserting the valve seats of pumps and condensers. It will bore and tap holes up to 10in. diameter, the three spindles working simultaneously. It consists of a heavy foundation bed, carrying a slide with a circular table 5ft. 9in. diameter, which may be revolved by hand or power in either direction, and moved by hand between the standards, these three motions being controlled by handles in front of the machine. The drill headstocks are mounted on a cross slide supported on standards 6ft. apart, which are secured firmly to the bed and tied by a top rail. The machine admits 7ft. high from top of table to the underside of spindles. Two headstocks are carried on short projecting arms on which they slide, and the third slides on the main cross slide, and is provided with reversing motion for tapping and studding. All three spindles are balanced for quick withdrawal, and are of hard forged steel 4in. diameter, with phosphor bronze adjustable bearings. The drive is through mitre and bevel gearing, with planed teeth, from a vertical shaft, which is driven by cone and double gear by an enclosed type motor fixed to the bed and driving by belt to the cone pulley. Each spindle is provided with hand

HORIZONTAL RADIAL DRILLING MACHINE

JOSHUA BUCKTON AND CO., LIMITED, LEEDS, ENGINEERS



and power feeds, which may be instantly stopped or started, and the two drilling spindles have ratchet motion into rack pinions for traversing them along the projecting arms; the arms and the headstock mounted on the cross slide are also adjustable by rack and pinion by means of ratchet levers. The cross-slide is raised and lowered by power, the whole of the motions being obtained from the one motor. All gearing is machine-cut, and is protected by cast iron guards. The total weight of the machine is about 25 tons. On page vii. is shown a ten-spindle machine made for drilling the underframe, girders, &c., of locomotives and wagons. Each spindle has independent driving motion by machine cut mitre and spur gearing from a long shaft running the full length of the machine, and driven by a four-speed cone and gearing at the end of the cross slide. The feed motions are worked from a shaft inside the cross slide from a worm wheel and drop worm at the end of the slide; the feed and revolution of each drill may be stopped or started independently. The spindles are of hard steel, and each revolves in a long gun-metal sleeve, in the face of which the rack is cut for the feed motion. They are balanced for quick withdrawal. The headstocks may be adjusted on the cross slide independently, and the whole lot may be moved simultaneously by the star handle at the end of the slide, which is provided with spring stop dividing motion, giving a spacing of one-eighth to the drills. The table is fitted on square slides on the face of angle brackets, which rise and fall on square gibs on the face of the standards. Planed tee grooves are provided in the top of the table, and a trough is formed round the edge for lubricant. The motions of the table, both longitudinally and transversely, are fitted with dividing arrangement by quartering-box, giving spacings of one-eighths. The machine, we are informed, is capable of drilling ten 1in. holes in 80 seconds in tough steel 1in. thick, including adjusting the spindles.

Our third illustration, Fig. 14, shows a special attachment for crank turning, mounted on a 12½in. centre lathe. It has been designed primarily for turning double-throw cranks for road engines, steam wagons, &c. The crank-pins are roughed out of the solid forging by a tool of the full breadth, a crank of 3½in. radius and 2½in. wide being formed, we are told, in 1¼ hours. The arrangement consists of a strong, steady rest bolted to the ordinary face plate, and with the outer end supported on the bed. The turned end of the crank is inserted in a boss bored to receive it inside the cylinder shown, and the webs of the crank are secured between screw jaws arranged at the front of the support. The outer end is carried by a dummy centre head secured to the shaft, and having centres coinciding with the throw required. The forming tool is carried on a special forged steel rest, and is fed in at the rate of 200 cuts per inch. The outside of the webs of the crank are cut with a radius equal to half the throw of the crank in the same way, a suitable plate for this purpose being provided.

JOSHUA BUCKTON AND CO., LIMITED.

No Yorkshire firm has a wider reputation for machine tools than Joshua Buckton and Co., Limited, of Leeds. Indeed, some of the most powerful tools in the country have been made by them. The selection of recent machines of their make which we illustrate is fairly representative of the class of work they do. It will be observed that the machines are all of the heavy order. Fig. 16, p. ix., illustrates a vertical and horizontal planing machine with an open slide. The vertical stroke, or what may be called the slotting action, of the machine is 5ft., and the horizontal stroke, or planing action, is 6ft. The octagonal slide which carries the tool box has 2ft. of inward feed, and the tool box can be fixed at any quarter circle; thus the machine would face up the end of a casting 5ft. high and 6ft. long, and would also plane over the top of it for a distance of 2ft. from the face, also down the two sides right and left hand for a distance of 2ft. from the face. The moving head of this machine is exactly balanced, and is run at a speed to give 30ft. of cut per minute. At this speed a roughing cut can be taken over a surface of 20 square feet per hour. The machine is more open than the usual type of side planing machines made with fixed standards, horizontal beds, and double-ended cross-slide, and the attendant is not between the frame-work of the machine and the work which is being planed, but he stands clear in front of the work, on the little platform shown on the engraving.

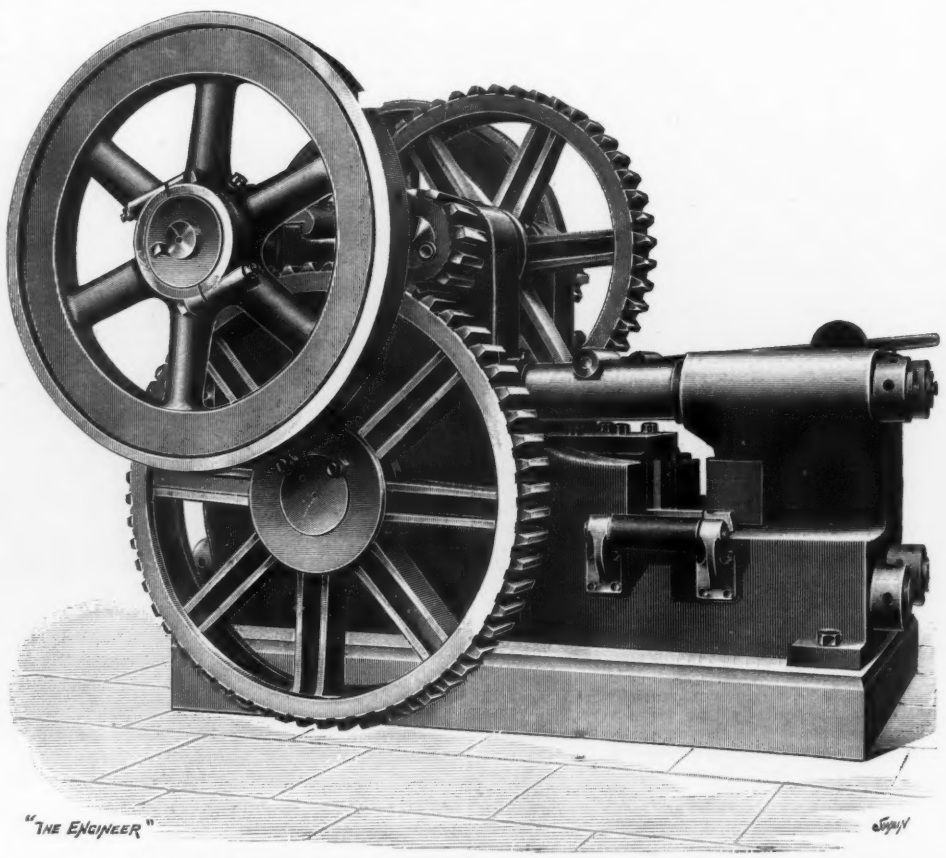


Fig. 15—POWERFUL BLOOM SHEARS—JOSHUA BUCKTON AND CO.

The accompanying sketch shows the design of the

PLANING AND BORING MACHINES

JOSHUA BUCKTON AND CO., LIMITED, LEEDS, ENGINEERS

(For description see page viii.)

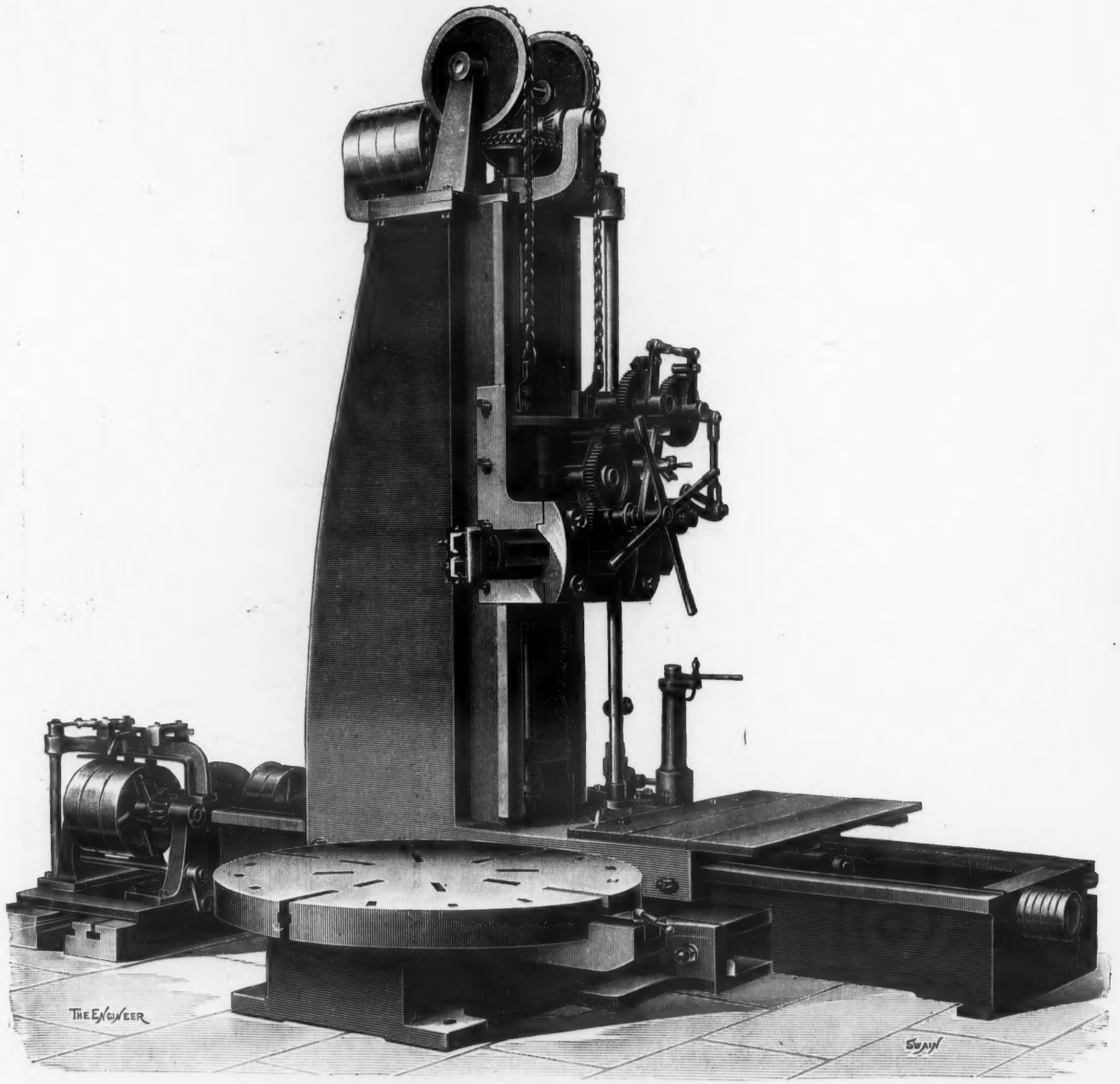


Fig. 16—VERTICAL AND HORIZONTAL OPEN-SIDE PLANER

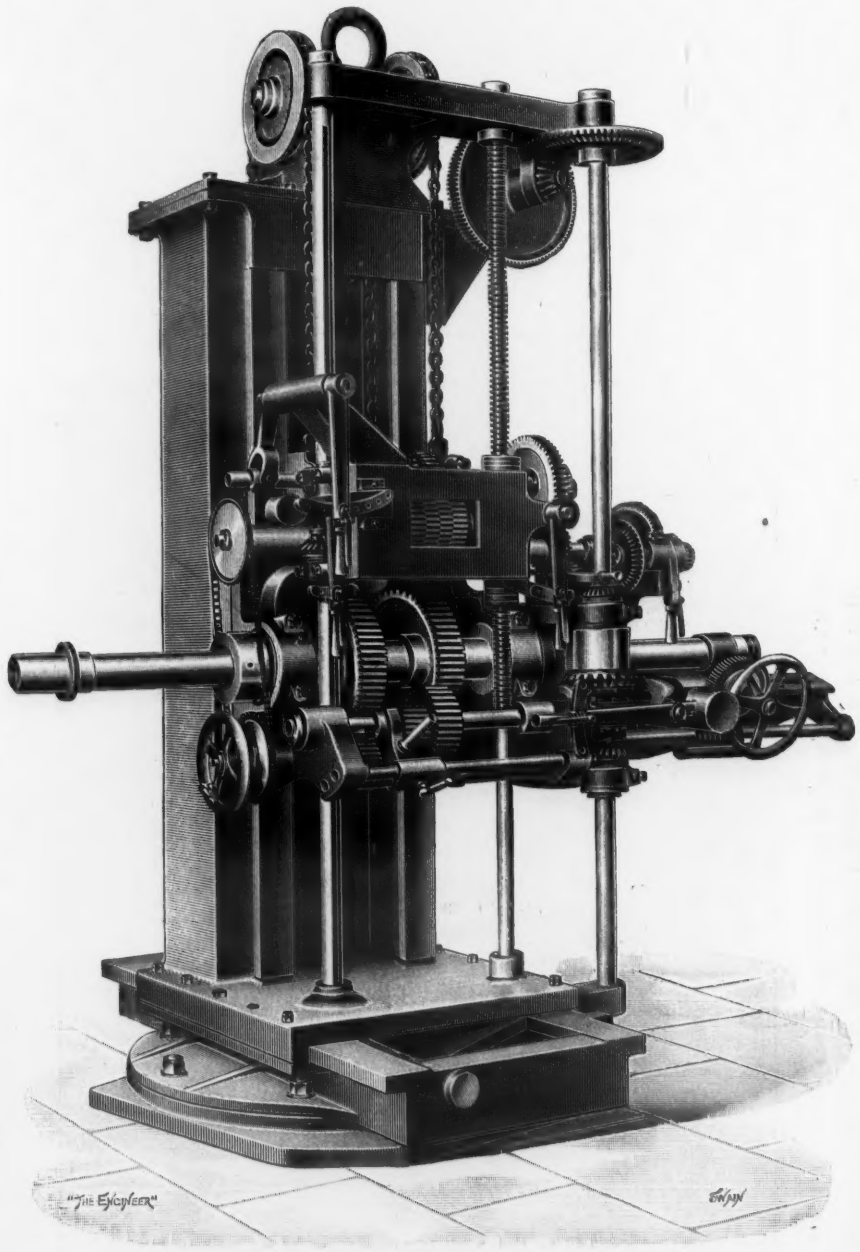
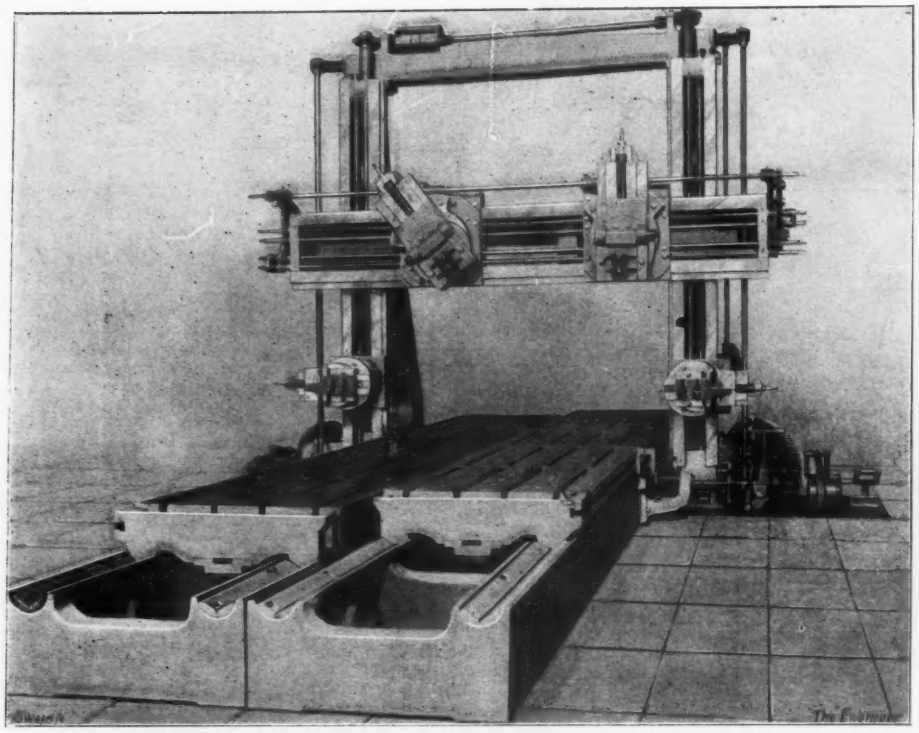


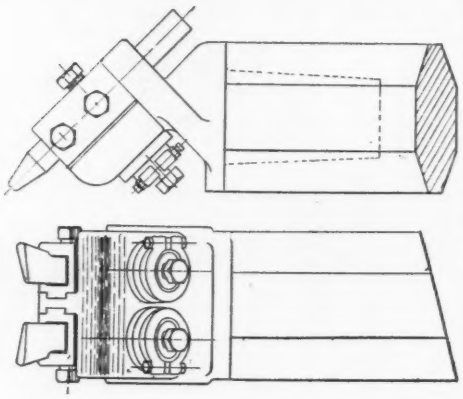
Fig. 17—PORTABLE ELECTRIC BORING AND MILLING MACHINE

DOUBLE TABLE PLANER

JOSHUA BUCKTON AND CO., LIMITED LEEDS, ENGINEERS

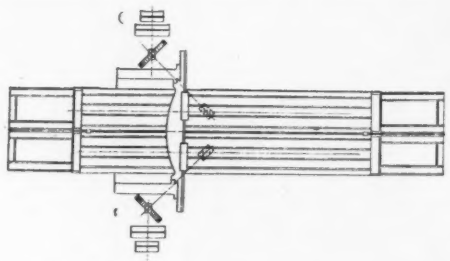


double-cutting tool box which adapts itself for planing any of the four surfaces which have been alluded to. It is obvious that in planing the tops of stanchions or standards this machine, where the work is stationary,



is more economical than the ordinary type of planing machine in which the work moves. It is also claimed for this machine that by the introduction of an efficient double-cutting tool box, thus saving the ordinary idle return stroke, it will plane over a larger surface in an hour and leave a better finish than a surface milling machine with the best form of inserted cutters. It is also much more readily adapted for cutting into corners than any milling tool.

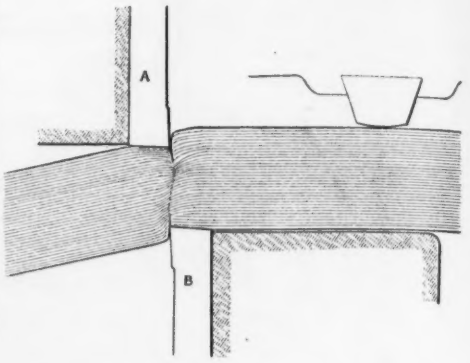
A planing machine with four tool boxes, to plane 25ft. long and 8ft. square, is shown above. A special feature of this machine is that the tables are separate, and can either be worked simultaneously as one table, or quite independently of each other upon two narrow pieces of work. The tool boxes on the cross slide are fitted with a special motion for planing internal curves. The drive of this machine is by Sellers gear, and the accompanying diagram shows how conveniently this



gearing lends itself to taking both sets of driving pulleys out of the way behind the face of the uprights. Where both sides of the machine have to be working sides, it is a great advantage to dispose thus of the driving gear, and thus leave the side tool boxes and the controlling gear perfectly accessible and open. The only difference between working this machine with a single table or with two tables is in connecting or disconnecting the belt striking gear. If the belt striking gear is connected and the belts at both sides are struck simultaneously, the two tables travel absolutely side by side. Whenever it is required to drive the tables independently, the belt striking gears are disconnected, and as each table has its own knockers, each can be made to take any requisite length of stroke independently of the other.

Fig. 15 shows a shearing machine which cuts steel blooms, of a tensile strength of 40 tons to the inch, cold, up to 6in. square. It will be seen that the anvil of the machine, which carries the fixed knife, is bolted through to the main body by four hammered steel bolts, and the anvil is formed with a perfectly open jaw, so that as the pieces are cut they are pushed through the jaw of the machine indefinitely, and will either find their way on to a bogie, or would fill up the yard with severed pieces, but in whatever quantity they were piled, would never choke the machine. The machine is driven by a 40 horse-power electric motor, driving by two belts on to the fly-wheel rims. The fly-wheels are paired, and balance each other across the machine. The main driving wheels are also paired. The excentric shaft drives the slide which carries the moving knife through an arm, which can be lifted out of gear to stop the cutting action until the bloom is in correct position. The fly-wheels have split bosses, and are gripped upon a hob; the hob is keyed fast upon the shaft with sunk keys, but the fly-wheels drive through friction only, so that if too large a bloom were put into the knives, the fly-wheels would surge, and the machine would refuse to cut before anything was broken. The arms of the main wheels are made of H section, with the flanges disposed in the direction which gives each arm the greatest strength as a cantilever. The teeth of the wheels are wider than usual, but are bevelled off at the outsides. Thus the working portion of the teeth is given the same support that it would receive from shrouding, but enabling the gearing to be examined through and through, which cannot be done if shrouding is employed, and which is particularly important in the case of paired wheels, as they can be of no benefit unless the teeth are bearing equally in both wheels.

The accompanying diagram shows the action of a shear in cutting through a thick bar. The diagram illustrates the operation at the moment preceding the complete separation of the bar. A is the moving steeling attached to the slide, B is the fixed steeling attached to the anvil. As the moving steeling advances towards the fixed



steeling, the bloom is compressed between the two until each steeling has made an imprint on the bloom. In making this imprint it cuts its way about ½in. deep through the fibres of the bloom, and owing to the great distortion of the fibres flowing under the compression of the base of the steelings, a crack is set up in advance of the ½in., which is veritably sheared by the steelings. From this point no more cutting is done by the steelings, but the pressure from the two opposite sides compels the fibres of the bloom to yield, as shown by the dotted line, without the edges of the steelings themselves ever coming in contact with the ruptured section. The diagram has been taken from an actual experiment in which the machine was run at such a speed as to pull up when it was at the stage of the cut shown on the diagram, and the dotted line on the diagram is taken from other speci-

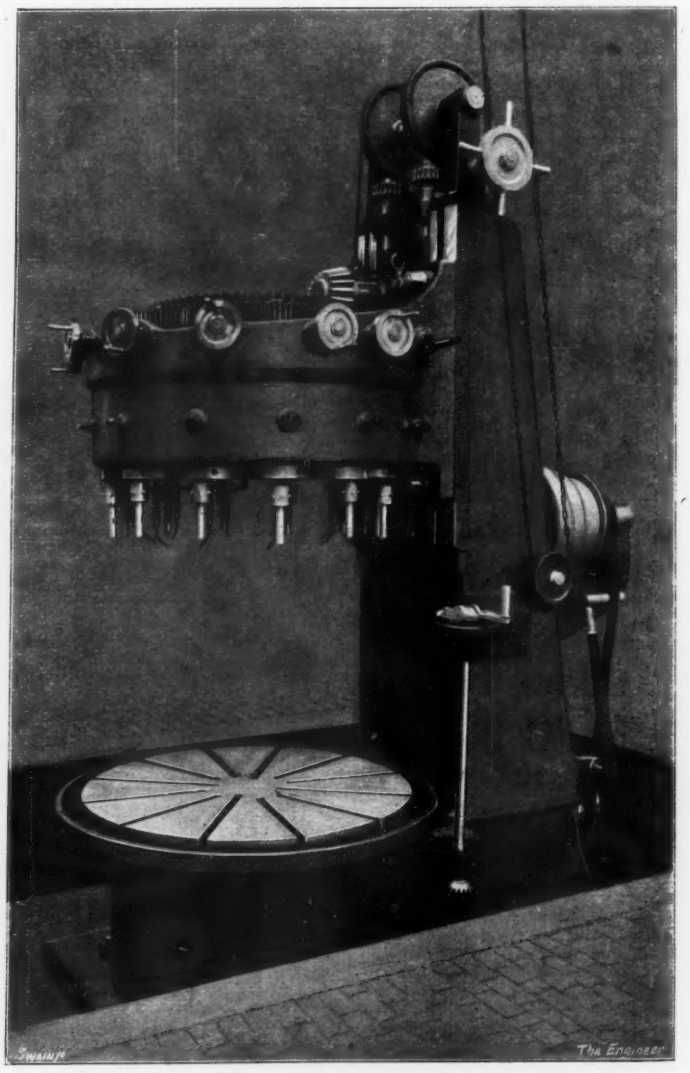


Fig. 18—FLANGE DRILLING MACHINE—LOWMOOR COMPANY, LIMITED

mens in which the cut was completed. The sketch is reduced from a section laid down to full size.

A portable machine for drilling, tapping, boring, and milling is shown in Fig. 17. It is entirely self-

BOILER DRILLING MACHINE

LOWMOOR COMPANY, LIMITED, BRADFORD, ENGINEERS

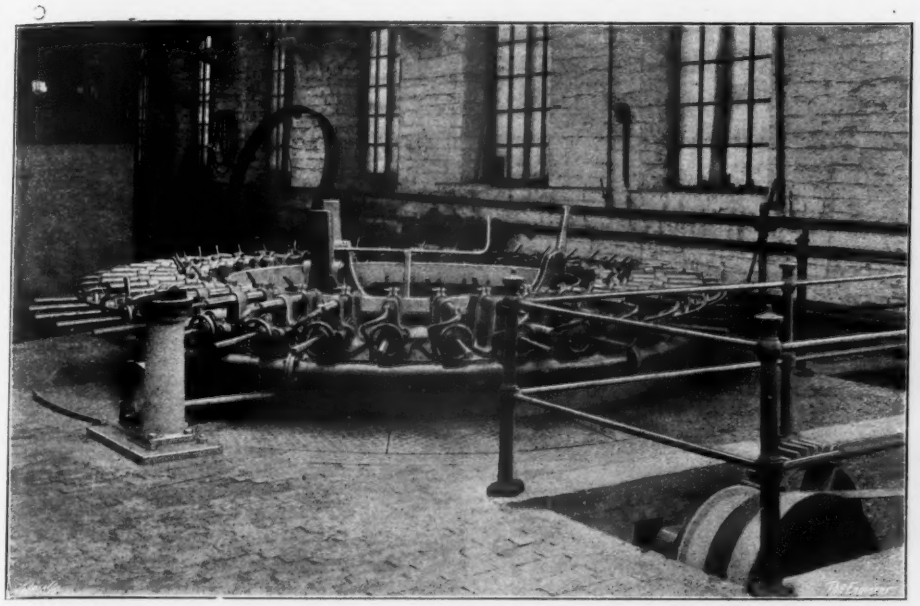
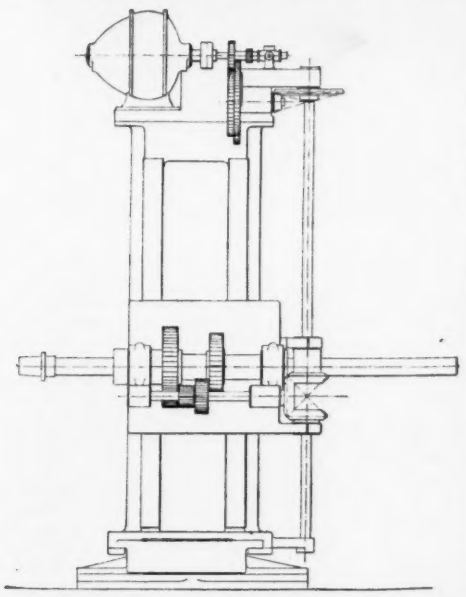


Fig. 19—BOILER DRILLING MACHINE—LOWMOOR COMPANY, LIMITED

contained, having its own electric motor, the diagram below representing a very similar machine, showing the scheme of gearing between the motor and the spindle. On the first-motion shaft there are two



pinions, to give it reducing speeds to the second-motion shaft. On the third-motion shaft there is a nest of mitres with a clutch reversing motion; on the fourth-motion shaft there is another pair of wheels for giving different reducing speeds to the spindle. The motor also is arranged to run at varying speeds, so that between the variations on the motor and the variations on the gearing the spindle can be driven at suitable speeds for drilling small holes or driving a 12in. diameter cutter head for either boring or milling. The spindle is 4½in. diameter, with 30in. self-acting feed motion. The spindle headstock is counterbalanced, and has a range of 5ft. vertically. The upright has a horizontal range of 3ft., and will swing round the complete circle. This type of machine is greatly favoured by makers of large dynamos and by engine builders. The machine, being portable, can be placed in the centre of the magnet ring or casing of a large alternator, and can mill, drill, or bore the surfaces for the attachment of the magnets all round the circle, the machine always being swivelled to present its spindle at the proper angle, the work being thus machined at one setting, the tool only being moved. It is also useful for milling and drilling the ends of fly-wheel halves or segments, or of wheels which have to be built up. The feed motion is positive, and can be rapidly changed over its whole range, and in addition to the boring and tapping feeds, the machine can mill with a vertical traverse or with a horizontal traverse; all the motions are controlled from the saddle.

On page viii. is illustrated a horizontal radial drilling machine of an exceptional type. It is driven by an electric motor, the arrangement of which is well shown. The radial arm is balanced, and can be swung through a half circle by means of a worm segment and worm worked by a ratchet. This is a cheap and useful form of drill for a large variety of work which would otherwise have to be placed in a pit under a vertical machine. It may be here remarked that, when there is no other objection, horizontal drilling has the advantage over vertical drilling, in the fact that the hot cuttings, instead of packing at the bottom of the hole, fall freely out of the mouth of the holes and let the drill work cooler. As may be seen in the engraving, the machine is fitted with a reversing clutch for tapping, and with a quick hand return to the spindle.

LOWMOOR COMPANY, LIMITED.

A set of interesting drilling machines made by the Lowmoor Company, Limited, of Bradford, are illustrated on this and the previous page. The machines are all for boiler work, and they have been got out with the object of economising in time, space, and attention.

The machine illustrated above is intended for drilling the rivet holes in the circumferential joints of boiler shells. It consists of a large circular frame or bed, firmly secured to suitable foundations, and having its upper and outer surface machined to receive the drilling heads, of which there are thirty-six. These drilling heads are all arranged in a circle, having their spindles in a direct radial line with the centre of the machine, and having sufficient range of traverse to allow boiler shells from 6ft. 6in. to 9ft. diameter to be drilled. The shell to be drilled is carried in a vertical position on a large circular table, which fits into a recess in the main casting,

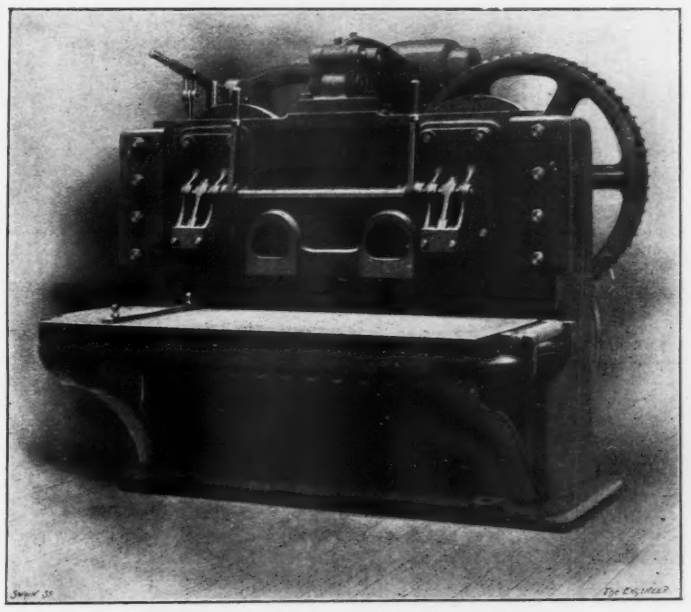
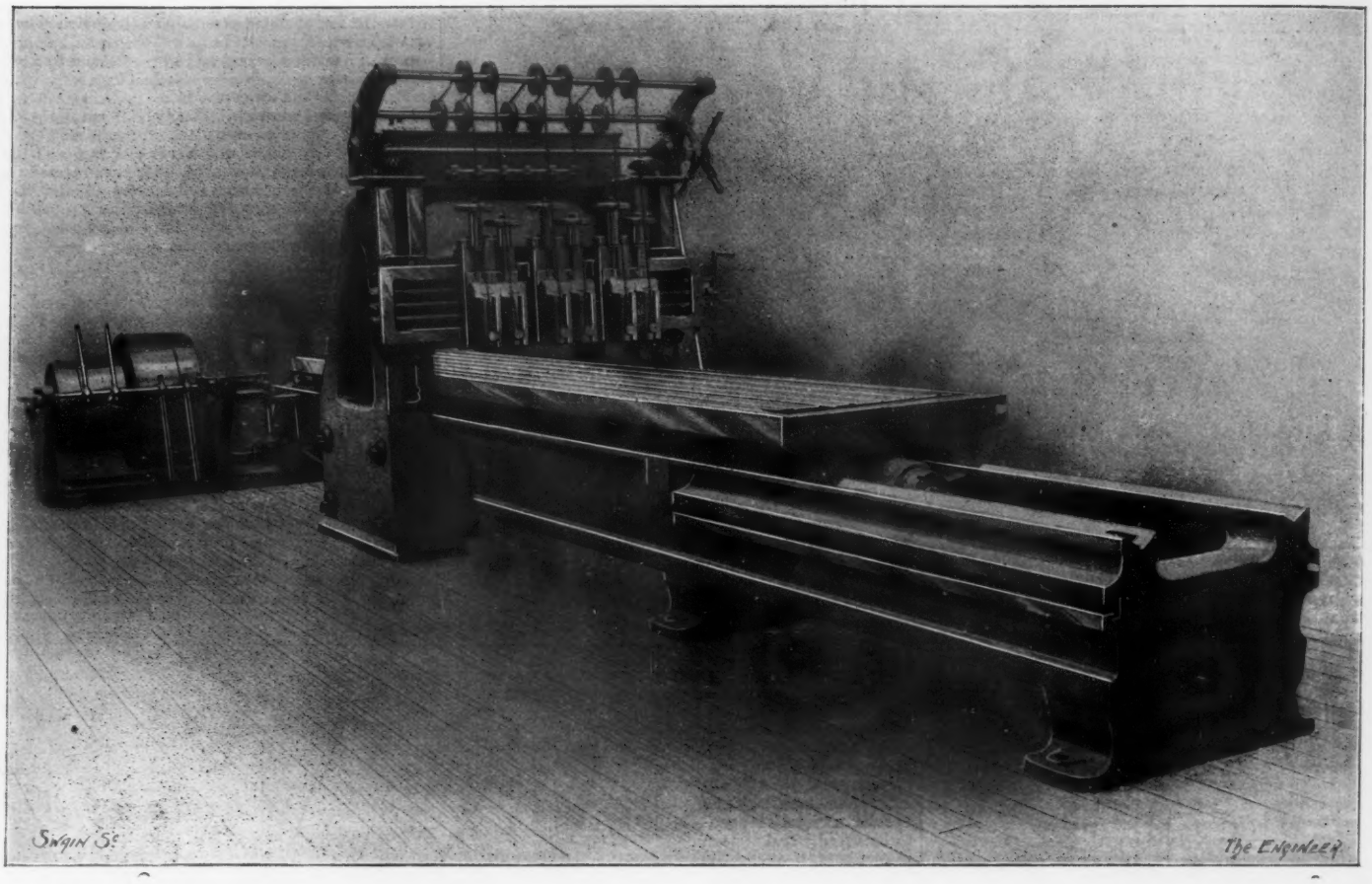


Fig. 20—MULTIPLE PUNCHING MACHINE—RUSHWORTH AND CO.

and can be rotated, raised, and lowered. The spindles are driven by a large three-speed cone pulley through spur and bevel gearing and a large bevel wheel or ring, made in two halves, which revolves round a bearing prepared for it on the main bed. To the back of this bevel ring is firmly secured a large spur ring, also made in two halves, and gearing into this spur ring are thirty-six pinions, one for each drilling head, keyed on vertical shafts, which run in bearings attached to the under side of the drilling heads. On the opposite end of each of these shafts is keyed a mitre wheel, which drives a similar wheel keyed on the drilling spindles. An adjustable bearing, carried from the drilling head, is also provided for the purpose of supporting the spindle when drilling the smaller sizes of shells, and a circular guide plate, carried by adjustable arms from brackets fixed to the main bed, with steel bushes for the drills to revolve in when drilling, which also effectually prevents the same from "running" during the process of drilling. A differential feed motion is provided for traversing the drills, any number of which can be drilling at once. A hand motion for adjusting the spindles is also attached to each drilling head. The table can be raised or lowered to suit the position of the holes in the shells by means of powerful hand motion, through worm and wheel, and large central supporting screw, which also serves as a centre upon which the table rotates, this motion being required when the number of holes to be drilled is a multiple of the number of drilling spindles. The dividing motion is through worm and wheel, similar to the well-known dividing motion on wheel cutting machines. The shells are secured in position on the table by means of three powerful jaws, moved simultaneously by means of screws, each screw having a bevel pinion on the end nearest the centre, and all gearing into one central bevel wheel, so that whichever screw is turned motion is transmitted to all and renders them self-centering. In the engraving the elaborate system for supplying lubricant to the drills is well shown. The lubricant is pumped into a ring pipe, from which it is taken by flexible tubes to adjustable

PLANING AND FLUTING MACHINE

RUSHWORTH AND CO., SOWERBY BRIDGE, ENGINEERS



nozzles placed one above each spindle. The dividing head is mounted on a pillar outside the machine. The spindles are 1¾in. diameter, and will drill holes up to 1in. diameter in any shell ranging from 6ft. 6in. to 9ft. diameter, and up to 4in. from the edge of the shell.

The machine illustrated by Fig. 19 has been specially designed for drilling the rivet holes in the longitudinal joints of boiler shells. It consists of a box bed with a V slide on its upper face, machined to receive a saddle which carries the drilling heads. This saddle is provided with two ⊥ slots on its upper surface for securing the drilling heads, which are ten in number, and are adjustable down to 5in. centres. A three-speed cone pulley acting through spur gearing to a large multiple-threaded screw, drives the drilling spindles by means of gun-metal worm wheels. Each spindle has power feed motion, and either one or any number of drills can be advanced together, or withdrawn by means of quick return. Each spindle can also be adjusted separately by hand. The saddle can be traversed on the main bed by means of screw, mitre wheels and hand wheel placed in a convenient position at the back of the machine. The shell to be drilled is carried on four rollers, all adjustable, so that any size of shell from 6ft. 6in. to 9ft. diameter can be operated upon. A powerful stay for taking the thrust during the process of drilling fits against the inside of the shell in a direct line with the centre of the drills, this stay being supported by two strong brackets, one of which acts as a centre for the stay to swing on, making it an easy matter to place the shells in position to be drilled. This stay is shown in position in the engraving. Two other adjustable stays, fastened by bolts in ⊥ slots running along the front of the main bed, keep the shells in position sideways.

Fig. 18 shows a machine of somewhat novel design. It is used to drill twelve holes at once in the flanges of boiler flues. It consists of a vertical standard, upon the face of which is bolted an adjustable bracket carrying the drilling spindles. The spindles are twelve in number, and are adjustable radially to suit flues varying in diameter from 2ft. 6in. to 3ft. 6in. Each spindle is driven by pinions from one central wheel.

The flues are carried upon a circular table, which is fitted with dividing motion for pitching the rivet holes. It is also provided with vertical feed motion for drilling with quick return by belt motion at back of machine.

These three machines constitute, we think, quite a remarkable set of machines for the boiler shop.

RUSHWORTH AND CO.

A multiple punching machine specially designed for wagon building by Rushworth and Co., of Sowerby Bridge, is shown in Fig. 20. Two machines of this kind have just been sent out to India, for railway companies. One machine for the East Indian Railway was made to punch eighteen holes ⅛in. diameter through plates ⅜in. thick, at 2½in. pitch; eighteen holes ⅜in. diameter through plates ⅜in. thick, also 2in. pitch. The other, for the Bengal and North-Western Railway Company, was made to punch twenty holes ⅜in. diameter through plates ⅜in. thick, 1¾in. pitch, eighteen holes ⅜in. diameter through plates ⅜in thick, 2in. pitch, and fourteen holes ⅛in. diameter through plates ⅜in. thick, 2½in. pitch. These machines are fitted with an arrangement at the left hand, whereby all the holes along the side of a long plate can be punched to one pitch; the punches and dies are set so that after punching one set of holes the plate is moved forward till one of the holes makes the proper pitch with the bar or peg which comes through the slide. The lever is then brought down, and a second set of holes is punched along the side of the plate, the distance between the two centre holes being as accurate as any of the others. This arrangement has the advantage that a short machine does the work of a long one.

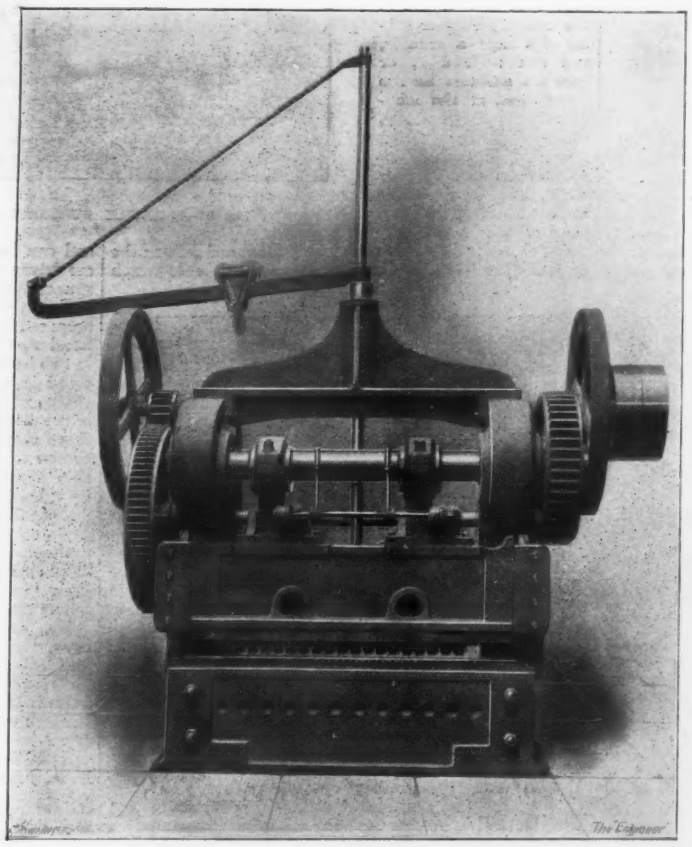


Fig. 21—MULTIPLE PUNCHING MACHINE—RUSHWORTH AND CO.

Another multiple punching machine is shown in Fig. 21. It has an open gap, so that a plate can be passed right through and holes punched in any part of it. The tool illustrated will punch thirty-six holes $\frac{9}{16}$in. diameter through a plate ¼in. thick at 1½in. pitch, and will admit a plate between the standards 5ft. wide. The punches and dies are arranged to slide in steel boxes from 1½in. minimum to any desired pitch within the capacity of the machine. The slide is fitted with stop motion, and is driven by a steel excentric shaft through strong double-power gearing shrouded to the pitch line.

At the top of this page is shown a planing or fluting machine, specially designed for fluting rollers for skutches, opening machinery, spinning machinery, &c., by the same firm. It is arranged to flute three steel rollers, 3in. diameter, at once, or six rollers, ¾in. to 1½in. diam. The bed is 21ft. long, and 14ft. in length can be planed. The table is 2ft. 9in. wide and 14ft. long, with a tray at each end and side to catch the water. A tank is fitted across the top of the standards, and a centrifugal pump is provided for keeping it full of lubricant. The cross slide is arranged to rise and fall by hand power, and is fitted with three sets of tool-boxes, two to a set, to feed by hand only. The tool-boxes are fitted with self-acting gear for lifting the tools clear of the work on the return stroke of the table. The table is driven by a steel screw with double adjustable brass nut, so that the slightest wear can be taken up. At each end of the screw there is a double-thrust bearing.

THE PROPOSED INTER-OCEANIC CANAL.

No. IV.*

ALTHOUGH they happen to be of particular gravity, it must not be assumed that the three problems which were discussed at some length in our last article exhaust the list of difficulties likely to be encountered in the construction and maintenance of a ship canal over the Nicaragua route. As a matter of fact, there are few sections of the projected line which do not threaten trouble more or less serious. That this is a forecast fully warranted by facts will appear from the necessarily brief survey of the route and works recommended by the latest Commission which we shall now present. Readers may probably find it convenient, in this connection, to refer to the route map and sections published in THE ENGINEER of the 2nd ult.

From the shore end of the projected harbour at Greytown, the canal line passes through a region very properly styled the "swamp section." The surface is but little above sea level, and the soil is generally mud mixed with decaying vegetable matter, which, near the sea, is 3ft. or 4ft. deep, underlaid with sandy silt extending from 50ft. to 112ft. below sea level, and, a little further inland, rests on clay at a depth often exceeding 30ft. The low hills here and there are heavily timbered, but the prevailing vegetation is coarse swamp grass. After the first crossing of the Misterioso, and for several miles, the swamp surface is from 5ft. to 10ft. above tide. The swamps communicate freely with the San Juan River through the San Juanillo and other streams; and at the site of Lock 1, about 7½ miles from Greytown, the flood rises 11ft. above sea level. To exclude this flood water from the canal the San Juanillo must be diverted, and embankments raised on each side. These are to have a minimum width at the top of 15ft., the crests being 5ft. above the highest flood levels, with side slopes of 1 to 3. This section terminates with a lock, which it is proposed to build in a hill on the south-west side of the Rio Misterioso, having a lift of 36½ft. above mean low tide; and the estimated cost, exclusive of the lock, but including an approach wall, embankments, and the necessary river diversions, is £1,042,628—in our opinion not excessive.

Even more unfavourable, however, are the conditions in the next section, which is also invariably swampy. Throughout nearly the entire length, embankments will be necessary not only to maintain the canal level at its minimum elevation of 36ft. above mean tide, but also to exclude floods from the San Juan and the hills north of the line. There will also be required a waste-way, which it is proposed to build on clay, no suitable rock foundation having been found near the Silico Hills, where the flood level of the San Juan is below the level of the canal. This work, as proposed, will be a simple overflow weir 600ft. long, and designed to prevent the canal level rising above elevation 37·5. For considerable distances the soft material beneath the swamp will have to be removed for a width of 30ft. or so at the bottom, in order to ensure the safety of the embankments; and to form the latter clay will have to be borrowed from the hills. This section is eleven miles in length, and its estimated cost is rather less than £1,300,000.

In the section from Lock 2 to Lock 3 an attempt has been made to so locate the canal line, that, on the one hand, there shall be comparatively little risk of injury from the San Juan floods; on the other, that as much heavy work as possible should be avoided in cutting through the Tamborcito, Tambor Grande, and San Francisco ridges. The line intercepts the drainage from about 75 square miles to the northward, and crosses a number of streams, large and small. In order to submerge the swamps, the canal level is to be maintained at a minimum elevation of 54·5ft.; and to provide against danger from floods, the level of which in the San Francisco region appears to be 56ft., three concrete overflow weirs are suggested, one in the Serapiqui Hills, 500ft. long, one west of Tamborcito of the same length, and the third near the Rio Danta, of 1000ft. With these it is estimated that the water in the canal will never rise more than 2½ft. above the normal stage. It is worthy of note that the swamp bottoms in this part of the line are usually of clay silt, and therefore likely to settle under embankments, and that the borings made at the site of the Danta wasteway have so far failed to reveal suitable material for foundations. The cut in the Tamborcito ridge is the deepest on the Nicaragua route, and will consist largely of hard basaltic rock.

The excavation in the section between Locks 3 and 4 will be mainly in earth, soft mud in crossing the valley of the Machado, and rock near the site of the terminating lock. Two embankments will be required between the canal and the Rio San Juan, one across Embankment Creek, the other across the Machado, and in each case the surface material is so soft that much of it will have to be excavated in order that the embankment may rest on a safe foundation. There will also be needed a weir, 300ft. long, to control the surface of the reach, between elevations 73ft. and 76ft.

The canal in excavation from Lock 4 to the San Juan River forms part of the summit level, the upper end being 3·3 miles by the river from the dam site at Conchuda. In it there will be encountered much deep cutting; for instance, in one place, the depth from the surface to the bottom of the canal on the centre line is 218ft., in another 170ft. The borings show a stratum of clay, 10ft. thick, underlaid with rock.

The most important feature of the first section of the canal between Lake Nicaragua and the Pacific is the cut through the continental divide. The surface of the ground rises gradually for about five miles until the divide is reached at elevation 153. The maximum depth of the cut on the centre line of the canal is 87ft., the average for about three miles being 75ft. The rock varies from partially disintegrated sandstone to hard trap, and it is estimated that the construction of the projected waterway through the mountain chain will involve the taking out of some 19,000,000 cubic yards of excavation, or about one-tenth of the computed spoil of the entire scheme. From the lake to the divide the canal line follows first the course of the Rio Las Lajas, which it crosses four times in a distance of 1½ miles, and then that of the Guiscoyal. From the divide it follows the valley of the Espinal to the Rio Grande, and then continues in the latter's valley to the Pacific. South of Lock 5, a small dam, with a masonry core wall extending to rock, will be thrown across the Rio Grande for the purpose of maintaining the summit level; and the estimates also provide for receiving basins and overflow weirs acting as sand-catchers at points where the waters of the Rio Grande and Chocolata enter the canal. The river channels will have to be sufficiently enlarged to pass the estimated maximum floods with velocities unlikely to interfere with navigation.

In the section between Locks 5 and 6 the valley of the Rio Grande widens into the so-called Tola basin. The canal prism will be almost wholly in excavation, consisting mainly of sandstone, which at the surface is much disintegrated. The estimates for the following section to Lock 7 include provision for a new channel for the Rio Grande, embankments 20ft. to 30ft. in height, where the canal crosses the river bed, and a waste-way for the discharge of surplus water from the canal. The excavation, except in the neighbourhood of the lock sites, will be mostly in sandy earth, and very similar conditions prevail in the section to Lock 8, and that of which the artificial harbour at Brito forms the terminal.

For construction purposes a railway is, of course, essential; and provision appears in the latest estimates for building two sections, one from Greytown to the mouth of the Savalos River, with a branch line to the Conchuda dam site, the other from the west shore of the lake to Brito. The distance between Savalos and Fort San Carlos it is proposed always to traverse by boats, but no explanation is offered as to how this is to be made practicable during the very considerable period required for work on the San Juan itself.

The total estimated cost of constructing the canal, as planned by the Isthmian Canal Commission, is 189,864,062 dols., or £39,147,230, tabulated as under:—

	Miles.	Cost. dols.
Atlantic sections:—		
Greytown harbour and entrance	2·15	2,198,860
Greytown harbour to Lock 1, including approach wall to lock	7·44	4,899,887
Diversion of Lower San Juan	—	40,100
Diversion of San Juanillo	—	116,760
Lock 1, including excavation	·20	5,719,686
Lock 1 to Lock 2, including embankments, waste-way, and approach walls	10·96	6,296,632
Lock 2, including excavation	·20	4,050,270
Lock 2 to Lock 3, including embankments, waste-way, and approach walls	16·75	19,330,654
Lock 3, including excavation	·20	3,832,745
Lock 3 to Lock 4, including embankments, waste-way, and approach walls	2·77	4,310,580
Lock 4, including excavation	·20	5,655,871
Lock 4 to San Juan River, including embankments and approach wall	5·30	8,579,431
Conchuda dam and auxiliary waste-way, including sluices, machinery and approach channels	—	6,062,972
River and Lake sections:—		
San Juan River section	49·64	23,155,670
Lake Nicaragua section	70·51	7,877,611
Pacific sections:—		
The lake to Lock 5, including river receiving basins and approach wall to lock	9·09	19,566,575
Diversion of the Las Lajas	—	199,382
Lock 5, including excavation	·20	4,913,512
Dam near Buen Retiro	—	125,591
Lock 5 to Lock 6, including waste-way and approach walls	2·04	3,259,283
Lock 6, including excavation	·20	4,368,667
Lock 6 to Lock 7, including embankments, wasteway, and approach walls	1·83	2,309,710
Diversion of Rio Grande	—	176,180
Lock 7, including excavation	·20	4,709,502
Lock 7 to Lock 8, including embankments, waste-way, and approach walls	2·43	1,787,496
Diversion of Rio Grande	—	117,580
Lock 8, including excavation	·20	4,920,899
Lock 8 to Brito harbour, including approach wall	·23	553,476
Brito harbour and entrance, including jetty	·92	1,509,470
Railway:—		
Equipped with necessary rolling stock, supplied with sidings, stations and water tanks, and complete for operation, at 75,000 dols. per mile	—	7,575,000
	183·66	158,220,052
20 per cent. added, for police, sanitation, and general contingencies	—	31,644,010
		189,864,062

The aggregate, as already remarked, is largely in excess of, with a single exception, all earlier estimates—a consequence, partly, of the increased dimensions which are now proposed, but more generally of the greater attention devoted to this important branch of preliminary investigation. It is interesting, in this connection, to note the growth of the estimated cost of the principal Nicaragua Canal projects presented during recent years for the approval of private adventurers or the Legislature of the United States:—

	£
Colonel O. W. Childs' estimate, including 15 per cent. for contingencies, made after survey (1850-52) for the American, Atlantic and Pacific Ship Canal Company—the work to be completed within six years from the time of breaking ground	6,502,700
Estimate, including 25 per cent. for contingencies, resulting from expedition under Commander E. P. Lull, U.S.N., fitted out by the United States Government in 1872	13,550,900
Mr. Menocal's estimate (1885), including 25 per cent. for construction contingencies only	13,203,800
Estimate (1888), including 25 per cent. for contingencies coming under the cognisance of the engineers of the Maritime Canal Company of Nicaragua	13,400,000
The same, revised, early in 1889, by a board of consulting engineers, inclusive of 20 per cent. for contingencies	18,103,000
Tentative approximate estimate (1895), based upon the Maritime Canal Company's plans and data, of the Nicaragua Canal Board, or Ludlow Commission	27,422,600
Estimates in preliminary report (December, 1898) of the Nicaragua Canal Commission:—	
Rear-Admiral Walker's	25,567,000
Professor Haupt's	25,360,000
Colonel P. C. Hains'	30,680,000
Final report of the Nicaragua Canal Commission (1899):—	
Rear-Admiral Walker and Professor Haupt	24,853,000
Colonel Hains	27,800,000
Preliminary report (December, 1900), of the Isthmian Commission, of which the above-mentioned gentlemen were also members	41,348,000

This table is certainly not lacking in suggestive material, and we cannot share the optimism evidenced in many circles in America to the effect that finality has at last been reached in the matter of Nicaragua estimates, and that the latest calculations are very unlikely to be exceeded or falsified by practical experience gathered during the period of construction. The latter would be a wonderful result, one almost unprecedented, as regards colossal enterprises of this type, in the history of engineering. Any ship canal project through Nicaragua must involve numerous hazardous structures, embankments, and the like, the cost and stability of which can only be completely tested when all the forces affecting them are in full and combined operation. There are, moreover, certain natural and mysterious influences which, though uncontrollable, require to be taken into serious consideration. Their presence has always been recognised—it would have been futile to ignore it—but usually somewhat lightly, and often, indeed, with a certain leaven of contempt. Recent manifestations, however, the earthquakes in Guatemala and the terrible volcanic eruptions in Martinique and St. Vincent, have opened the eyes of even those who would be blind to the fact that the Nicaragua Canal route lies in the direct line of seismic activity, and may at any moment feel the effects of this most dangerous distinction. Its peculiar liability to earthquake disturbances has always constituted to our minds a formidable argument against the construction of a Nicaragua canal, and we are not surprised to learn that, as a result of the events referred to, this risk has loomed large in recent Congressional debates. The subject has a very direct bearing upon the question of estimates, and this must excuse its present mention, in anticipation of the fuller reference proposed in our next article.

The latter will be specially devoted to a consideration of the comparative merits and demerits of the Nicaragua and Panama projects, each of which in turn and within a few weeks has been recommended by the Isthmian Canal Commission as the more "feasible and practicable." It consequently now behoves us to turn our attention to the plan for completing the Panama enterprise, which has been devised and urged upon Congress for adoption by the latest American board of investigation. The route and its various problems, and the progress made towards a solution of the latter and the completion of the undertaking, were so fully discussed in THE ENGINEER in the series of articles published in October-December, 1900, that our present task will be relatively brief. The proposals of the Isthmian Canal Commission constitute, to all intents and purposes, a revised and simplified version of the scheme formulated by the International Technical Committee of 1898. With this in the articles referred to we dealt very fully, being assured, notwithstanding all appearances to the contrary, and America's traditional leaning to the Nicaragua route, that the time was rapidly nearing when the best expert opinion of the world, the United States not excepted, would recognise that all reasonable hopes of an early realisation of the dream of centuries centred in the heretofore ill-starred enterprise between Colon and Panama. Since then we have seen the American Commission, which set out to ban, return with blessing, and more appreciative even than Europe of the long-ignored and apparently unavailing labours upon which may yet be based a great trans-oceanic highway.

The plan of the American Commission is, in general outline, identical with the "10-metre" project formulated by the International Technical Committee, and regarded by it and the Special Technical Commission as preferable, on all grounds other than the time required for construction, to the scheme, with higher level, actually recommended. Writing on November 9th, 1900, we expressed unqualified regret concerning the latter resolution, for, "granting that a satisfactory and definite solution has been reached in connection with the regulation of the Chagres, it is obviously most desirable that the summit level of the canal should be fixed as low as possible. A sea level waterway would be the climax of perfection; but since this is out of the question, the nearest practicable approach to it should be sought." The difference of cost, as estimated by the international board of engineers, amounted to no more than £760,000, a small matter as compared with the advantages to navigation resulting from a reduction in the number of necessary locks and the saving of first cost and permanent charges for the maintenance of the dam at Alhajuela and the 9¼ miles of feed-water conduit which formed essential adjuncts of the "20·75-metre" project. We are, consequently, in cordial accord with the United States representatives in their subordination of questions of time and expense to the more important consideration of efficiency. A few years and few millions of dollars more or less are of small significance to America. Moreover, as the Isthmian Canal Commissioners very pertinently remark:—"In a plan prepared for a Government seeking the permanent development of its possessions, and content to receive its return in an indirect way and at a future time, the canal must have dimensions which will permit the passage of the largest ships now afloat or

* No. III. appeared May 30th.

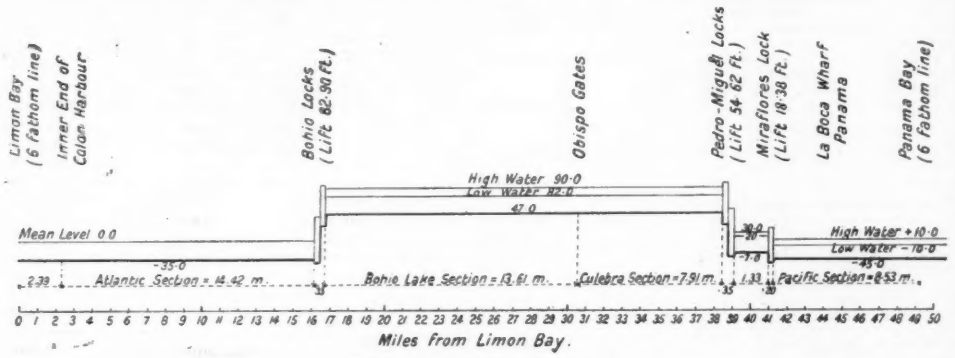
likely to be constructed. For a time such ships may be exceptional, and the canal revenue derived from them may be small. A plan prepared for a commercial corporation investing capital from which an immediate and direct revenue is desired would probably exclude such exceptional ships, and the dimensions given the canal—at least in the beginning—would be less than in the former case."

In the height of the dam which it is proposed to construct at Bohio will be found the *fons et origo* of all essential differences between the American plan and that fully described by us in 1900. The Technical Committee nominated by the New Panama Company designed to span the valley of the Chagres, at a point where it is comparatively narrow and on each side hemmed in by high ground, by a great water-tight embankment, 1286ft. long and 65½ft. high, the effect of which would have been to transform the country between the Bohio and Obispo locks into a navigable lake, with a bottom 23ft. above sea level. This would have served not only as one of the reaches of the canal, but also as a reservoir for the reception and storage of flood discharge. At Obispo there would have been required two groups of locks to attain the "divide" or summit level—68ft. above sea—which would have extended through the Emperador-Culebra cutting to Paraiso, whence the descent to the Pacific would have been made by three groups of locks. Moreover, for the purpose of feeding the summit level and completing the proposed system of flood regulation, another huge dam was projected across the Upper Chagres, behind which there would be a second reservoir, connected with the "divide" by means of a conduit. The American plan, however, is much more simple and, it may be added, advantageous to navigation. The height of the Bohio dam—to be constructed on a new site, where the borings reveal rock suitable for foundation only 128ft. below sea level—is to be increased to 100ft. above the same datum; and, as a consequence, the depth and area of the lake behind will be so enhanced that it will be possible to directly receive into this basin without risk of impeding navigation the full flood discharge of the Chagres. Fuller advantage will at the same time be taken of the favourable features of the country in the subsequent discharge of surplus waters. The proposed dam at Alhajuela will become unnecessary for flood control, and its construction is consequently postponed until largely increased traffic may demand storage capacity exceeding that provided by Lake Bohio. The latter will form part of the canal "divide," for the cutting through the mountain ridge will be lowered to 47ft. above mean sea level, and thus—eliminating the locks proposed at Obispo and Paraiso—the summit level will extend for a distance of 21·52 miles from the locks at Bohio to those of Pedro-Miguel.

of which about 301ft. is at the maximum depth of 128ft. Elsewhere cofferdams are to be used, the foundation at sea-level being extended 78ft. at the eastern end, and 246ft. at the western end of the pneumatic work. The cofferdams would reach to 8ft. above sea level, and all operations above that point would be carried on by the ordinary methods of dry work. The total length of the dam, as planned, is 2546ft., its total height above the lowest part of the foundation 228ft., and its width at the top 20ft. As the top will be 100ft. above mean sea level, the dam will have a super-elevation of 10ft. above the normal high-water level and of 8ft. above the highest possible level of the lake. The masonry core will be 30ft. thick at and below elevation 30, tapering from that level to 8ft. at top. The earth faces of the dam are designed to have mean slopes of 1 vertical to 3 horizontal, and to be broken by three terraces, each 6ft. wide. At present it is judged necessary to pave only the upstream face, but in all probability both faces would be heavily riprapped with rock spoil from the site of the adjacent Bohio locks. Material for the heavy filling required will also be found in the immediate neighbourhood. It is calculated that fully seven-eighths of the work could be completed without interference with the natural flow of the Chagres, and that when necessity arises to divert the river, the unfinished Gigante waste-weir and, later on, the completed locks at Bohio might, with the aid of a temporary dam, be employed as diversion channels. The total cost of the dam, as designed, is estimated at £1,313,300.

To provide for the flood control of the Chagres and the disposal of surplus waters from Lake Bohio, the American Commission has recommended a scheme differing only in completeness and minor details from that described in THE ENGINEER in the series of articles already referred to. The overflow will discharge through a concrete weir constructed in the bed of the Rio Gigante, into the Pena Blanca swamp, thence through natural and artificial channels to the Rio Chagres below Gatun, and from this point through the river to the Pacific. Generally speaking, ridges will prevent this water impinging upon the canal line, but for the low region near Gatun provision is made for protecting levées aggregating about five miles in length.

It only remains to mention that the new estimates provide for considerable improvements to Colon and Panama harbours, and for placing near Obispo a pair of gates, 100ft. wide, for the purpose of sustaining the level of Lake Bohio, should it ever be found necessary to draw off the water from the Culebra section. The United States Commission estimates that of the 77,000,000 cubic yards of excavation credited to the two French companies 39,586,332 cubic yards will be of value in connection with the new scheme, and that to complete the enterprise



GENERAL SECTION OF CANAL

The amount of excavation required to complete the cutting between Obispo and the Pedro-Miguel locks, a distance of 7·91 miles, is estimated at 43,237,200 cubic yards. This provides a bottom width of 150ft., with side slopes of 1 to 1, the entire cut being lined with masonry walls, rising to elevation 92, or 2ft. above high water, the wall faces being nearly vertical and furnishing benches on each side of the canal 38ft. wide, on one of which it is proposed to lay the Panama railroad, while on the other will probably be placed a service track. The esitmated cost of the 6·02 miles of very heavy work is £8,647,500, and of the entire section, including the upper approaches to the Pedro-Miguel locks, £9,157,600. Such a concentration of excavation in so small a space is probably unprecedented, and, in the opinion of the Isthmian Canal Commission, may call for eight years of labour. There should, however, be found—as suggested in our former series of articles—many compensating advantages. The work of the new Panama Company during recent years should be of great assistance in connection with more elaborate arrangements for the completion of the cutting. The cost of excavation has been estimated by the American Commission on the basis of about 3s. 3½d. per cubic yard, rather less than the unit price fixed by the Comité Technique in 1898; imperfect administration might, however, tend to increase it, whereas, with well-considered equipment and conduct of the work, great economies could doubtless be effected.

The Bohio dam, as now designed, will be a structure of great magnitude, of vital importance to the scheme, and offering not a few, but not necessarily serious, difficulties. The physical features of the proposed site, which appear to have been closely studied, are regarded as justifying the construction of an earth embankment with a heavy masonry core carried down to bed-rock throughout its entire length; and for reasons of economy this type of dam has been preferred to one wholly of masonry. It is proposed to sink the foundation of the core by the pneumatic process at all points where the foundation bed is lower than 30ft. below sea level, *i.e.*, for a length of 1314ft., according to its plans there remain to be removed 94,863,703 cubic yards of rock and earth, exclusive of the excavation required for the Bohio dam and Gigante waste weir. The estimated cost of the entire scheme is as follows:—

	Miles.	Cost. dols.
Colon harbour and entrance:—		
Six-fathom line to jetty	2·39 ...	1,936,991
Jetty to inner end of harbour		6,120,716
Harbour to Bohio locks:		10,649,492
Levées to exclude flood waters	14·42 ...	151,347
Lower approach to Bohio locks, 1200ft. long		299,000
Bohio locks, including excavation ...	·35 ...	11,567,275
Lake Bohio section:	13·61 ...	2,517,754
Upper approach to Bohio locks		434,400
Obispo gates	— ...	295,434
Culebra section, including upper approach to Pedro-Miguel locks	7·91 ...	44,414,460
Pedro-Miguel locks, including excavation and dam	·35 ...	9,081,321
Pedro-Miguel level	1·33 ...	803,406
Lock approaches at each end		388,880
Miraflores lock, including excavation and waste weir	·20 ...	5,781,401
Pacific maritime section:—		
Miraflores lock to La Boca wharf ...	4·12 ...	10,963,458
La Boca wharf to 6-fathom line ...	4·41 ...	1,464,513
Bohio dam	— ...	6,369,640
Gigante waste weir	— ...	1,209,419
Pena Blanca outlet	— ...	2,448,076
Chagres diversion	— ...	1,929,982
Gatun diversion	— ...	100,000
Panama Railway diversion	— ...	1,267,500
	49·09	120,194,465
Engineering, police, sanitation, and general contingencies, 20 per cent....	— ...	24,038,893
		144,233,358
		Say, £29,788,800

The photographs on page 608 show the country near the Upper Chagres, Cristobal Colon, and Obispo, the proposed site for the guard-gates.

SOME MODERN TENDENCIES OF LOCOMOTIVE ENGINEERING.

By CHARLES ROUS-MARTEN.

No. III.

SETTING aside for the moment, as being in a purely experimental stage, the new and colossal express engine recently designed and built for the Great Western Railway by Mr. W. Dean, to which I referred briefly in my previous article—THE ENGINEER, March 21st—the latest developments on that railway are found to be, as regards locomotives for passenger service, the two standard types known as the "Atbara" and "Camel" classes. Both of these have been illustrated in THE ENGINEER—August 2nd, 1901, and June 1st, 1900.

Practically they are simply improvements on the "Badminton" and "Duke of Cornwall" types respectively, and their coefficient of nominal tractive force is precisely the same as that of their precursors. Each has a boiler with 1663 square feet of heating surface; a large fire-box of the Belpaire pattern; inside cylinders 18in. diameter, with a piston stroke of 26in. Their "Badminton" and "Duke of Cornwall" predecessors had cylinders of identical dimensions and coupled wheels of 6ft. 8in. and 5ft. 8in. diameter respectively, like the "Atbara" and "Camel" classes. That represented, on the accepted formula $\frac{d^2 \times L}{D} = T$, a tractive force of 105 lb. and 124 lb. respectively for every pound of effective steam pressure in the cylinders. I do not give any fractions, because driving-wheel diameters are always changing with each visit to the turning shop, therefore whole numbers are quite sufficiently exact when the wheel diameters vary by an inch or more, according to the age of the tires.

Now it may be noticed that, so far as the dimensions of cylinders and coupled wheels go, the Great Western standard has now been fixed for several years. The wheels are 5ft. 8in. in the case of those locomotives which have to work the steepest portions of the Great Western system and heavy stopping trains, 6ft. 8in. for main line express duty on the easier lengths of road. But the cylinders in each case have been 18in. by 26in., and the boilers have, generally speaking, been virtually identical. That is to say, there has been little difference, if any, between the boilers of those engines of the 5ft. 8in. class which have raised fire-boxes and of the 6ft. 8in. class. Forty of each class were built, and then already the need of still greater power had made itself felt.

It is interesting to notice in what direction this desired increment of power was sought. Mr. Dean did not give to his new 6ft. 8in. and 5ft. 8in. classes 19in. or 20in. cylinders instead of 18in.; as a matter of fact, he did not enlarge the cylinders at all. He simply provided improved means of steam generation. That is to say, he gave the new 6ft. 8in. and 5ft. 8in. wheel engines far larger boilers and Belpaire fire-boxes, affording a total heating surface of 1663 square feet, while this heating surface was so disposed through the design of the boiler, the arrangement of the tubes, and the Belpaire pattern of the fire-box, that it represented in reality a much larger proportional effectiveness than was indicated by its mere area as compared with that of the previous engines. At the same time the steam pressure was increased to 180 lb. per square inch. The result has been seen in a remarkable enhancement of efficiency. Excellent as was the work done by the "Cornwalls" and "Badmintons," that performed by the 5ft. 8in. wheel "Camels" and by the 6ft. 8in. wheel engines of the "Atbara" type, both of which have the increased facilities for steam generation to which I have referred, has been substantially superior, although the nominal tractive force per pound of steam pressure in the cylinders has remained exactly the same as before. In fact, the work done by these two locomotive types is of a quality never previously seen on the Great Western. To a 6ft. 8in. coupled "Atbara" is given with perfect confidence such a load as was never formerly taken up the Wellington bank of 1 in 81 without the aid of a pilot. The "Camels" tackle with the utmost readiness and success loads such as no previous engine had ever hauled unassisted up the terrific gradients of South Devon and Cornwall, where 1 in 55 to 1 in 60 is quite a common grade, and where such terrors as 1 in 43, 1 in 41, and even 1 in 40 are met with on the main line over which expresses booked at average inclusive rates of over 40 miles an hour are daily run. Yet there has not been the slightest enlargement of the cylinders or increase in the nominal tractive coefficient. When more power was needed on various other railways in the years 1884, 1893, and 1896, it was sought through the enlargement of the cylinders from 18in. to 19in. in diameter. But the outcome was not enhanced efficiency, and all the railways which tried that plan have more recently fallen into line with the general movement in the direction of seeking augmented power in the proper quarter—enlarged boiler capacity. Even on the Great Western Mr. Dean himself did try 19in. and even 20in. cylinders, as in the case of his eighty 7ft. 8in. single-wheel "Amazons" and of his 7ft. coupled "Armstrongs." The first thirty of the former type had cylinders 20in. by 24in. and 1444 square feet of heating surface. But, as the result of practical experience, the next thirty were given only 19in. cylinders, with a heating surface increased to 1561 square feet, and the first thirty have all been fitted with cylinders of the smaller size, proving themselves more, and not less, powerful in consequence. That is to say, with a diminution of their nominal tractive force they exercise increased actual power. As for the 7ft. coupled "Armstrongs," with their 20in. by 26in. cylinders, they have never in my experience been satisfactory as express engines, and they are being rebuilt with the enlarged "Camel" boilers.

Thus, it will be observed, just as Mr. Aspinall tried 19in. cylinders originally on his "1093" class with 7ft. 8in. coupled wheels and 1216 square feet of heating surface,

but soon lined them up to 18in., and did not resume the 19in. diameters until he had provided a vast boiler with 2052 square feet of heating surface and a huge Belpaire fire-box, so Mr. Dean, after trying 19in. and 20in. cylinders, resolved to stick to 18in., and provide any needful increment of power by sending through these 18in. cylinders more steam and at a higher pressure. Indeed, in his latest express type, as I pointed out in my preceding article, while still adhering to 18in. cylinder diameter, he has sought further power advantage not only by increasing his heating surface to 2400 square feet and his steam pressure to 200 lb., but also by invoking the aid of leverage and lengthening his piston stroke to 30in. and his cranks proportionately, while gaining additional fulcrum by adding a third pair of coupled wheels, and so extending the adhesion.

I have dilated at some length upon these Great Western tendencies in locomotive practice, because they illustrate and enforce with curious cogency the principle which I have maintained to be the most prominent and important one in modern locomotive engineering—that extra power is to be sought in greater boiler efficiency and not in mere cylinder enlargement, the latter being not only useless, but actively mischievous, unless backed up by abundant boiler power. The fallacy has at one time or another influenced most locomotive engineers that, by providing large cylinders, drivers may be virtually compelled to work with greater expansion, and so save steam, and consequently fuel. It was once hoped that in this way the benefits of compounding might accrue without its theoretical drawbacks of increased cost and complication having to be undergone. But hard experience all too plainly demonstrated that with large cylinders and small boilers the drivers constantly ran their engines out of breath, and so lost time through shortness of steam. On the Great Western Mr. Dean has "found salvation" in an 18in. cylinder with adequate boiler, and it is noteworthy that this combination has been coincident with a marked and admirable improvement alike in the booked speeds of that railway, in the punctuality of its fast trains, and in the weight of the trains hauled at these higher speeds. The case of the Great Western is specially interesting because the 18in. cylinder diameter, which is its present standard, was adopted on that line so far back as the year 1847, and has been virtually continuous during the fifty-five years which have since elapsed. It is, I believe, true that 18in. cylinders were not employed in the narrow-gauge locomotives of the Great Western until the "999" class of 7ft. single-wheelers came out in 1875. It was not until 1877 that 18in. cylinders became at all general on other railways. But the standard broad-gauge express engines had 18in. cylinders from their advent in 1847 until their final extinction in 1892, and no engines ever did better practical work relatively to their nominal and theoretical available power than the 8ft. single-wheelers of the late Sir Daniel Gooch. It is remarkable that in 1902 the same cylinder diameter which he adopted in 1847 should still be found by his able successor of the present day to be the one most suitable to the enormously expanded requirements of the Great Western Railway.

(To be continued.)

THE CROSS-CHANNEL PASSENGER STEAMSHIP SERVICES.

No. XV.*

HAVING briefly described and illustrated in two previous articles some of the principal vessels of the fleet owned by the London and South-Western Railway Company engaged in the cross-Channel passenger services from Southampton, before closing our record of those services it will be interesting to note briefly those which the company are running to-day.

Premising that the boats of the company in the year 1900 carried 54,667 passengers to the Channel Islands, and 42,274 to French ports from Southampton, that port may fairly take its place as one of the principal in the kingdom for this special passenger traffic. The actual services now performed by the South-Western Railway Company steamers include:—To and from the Channel Islands: a daily service—Sundays excepted—during the summer, and three times a week from October 1st to May 31st, the boat leaving Southampton at 12.30 midnight, arriving at Guernsey at 7, and Jersey at 9.30 next morning; returning from Jersey at 8 a.m., and Guernsey at 10 a.m., reaching Southampton at 4.30 p.m. Some 56,500 passengers were carried to and from England during 1901, in addition to 12,500 carried between the two islands only. Up to October 1st, 1899, the winter service was a daily one like the summer, but at that date it was reduced to a tri-weekly one, the alternate three days' service being then performed by the Great Western Railway Company steamers to and from Weymouth. To and from Havre, a daily service—Sundays excepted—throughout the year; leaving Southampton at 12.20 midnight, and Havre at 11.45 p.m., the average passage being 7 hours, 1½ hours of which is made in the smooth water inside the Isle of Wight. A light mail is carried every night, and whenever the American mail arrives at Southampton after 5 p.m., the New York-Paris mail is shipped by this route. That it is steadily becoming a serious competitor with the Dieppe, Boulogne, and Calais routes may be gathered from the fact that 29,000 passengers were carried by it during 1901. The steamers performing this service—the Columbia, Alma, and Vera—have their first-class accommodation amidships in 34 two-berthed cabins, each on the same lines as those in the Atlantic steamers. They are placed on the promenade, main, and lower decks. The second-class accommodation is on the main deck aft, with a third large cabin on the lower deck. The emigrant traffic passing by this route is provided for below deck forward, and on the lower deck aft, iron bedsteads common to the Atlantic service being fitted for 100 passengers. The steamers enter and leave Havre Harbour at all states of the tide, having been specially designed for light draught. Interruption of the service by stress of weather is of very rare occurrence.

From Southampton to Cherbourg there is a service every Tuesday, Thursday, and Saturday at 10.45 p.m., returning from Cherbourg on Monday, Wednesday, and Friday at 12 o'clock midnight. The passenger trade with this port is small, but it is a favourite route for the cyclist through Normandy and Brittany.

From Southampton to St. Malo there is a passenger service on Monday, Wednesday, and Friday, the return journey from the latter port being on the same week days. Some 12,500 passengers to and from England travelled through this port in 1901. St. Malo being considered the front door of Brittany, during the busiest weeks of the tourist season the South-Western Railway Company's new twin-screw steamer Vera is put on this service. There is also a service twice weekly in each direction during winter, and three times weekly during summer between Jersey and St. Malo and Jersey and Granville. During the summer large numbers of passengers are carried, they being principally French tourists visiting the Brittany seaside.

For easy reference we give below in tabulated form a list of the present fleet of steamers belonging to the South-Western Railway Company employed in the cross-Channel passenger services, with some interesting particulars in connection with them, also our promised schedule of distances, and average time taken by the company's steamers in covering them, between Southampton and the Channel Islands and the French ports served.

Schedule of Distances from Southampton to French Ports, Channel Islands, &c.

	Miles.	Knots.	Average time of passage. hours.
Southampton to Havre	120 ...	104 ...	6½ to 7
,, ,, Cherbourg...	96 ...	83 ...	6 to 7
,, ,, St. Malo	174 ...	151 ...	11½
,, ,, Granville	175 ...	152 ...	—
,, ,, Guernsey	120 ...	104 ...	6
,, ,, Jersey (direct)... ...	141 ...	123 ...	7½
,, ,, Jersey (*viâ* Guernsey)	150 ...	130 ...	8
,, ,, Honfleur	129 ...	112 ...	—
,, ,, Needles	25½ ...	22 ...	1¼
,, ,, Nab Light...	22½ ...	19½ ...	1¼

All the steamers in the above list carry sufficient coal for the round voyage, with an additional quantity to cover all ordinary contingencies, the coal being all stowed in bunkers. On November 1st, 1892, the whole of the Southampton docks came into the possession of the railway company, but the old outer basin of the docks is used by its steamers, they being—with two exceptions—the sole utilisers of the quay spaces of this basin. The boats always landed their passengers at the docks, but up to 1864 it was the practice to embark them at the Royal Pier, the steamers taking in their cargo in the docks, and then going round to the pier for passenger embarkation.

The London and South-Western Railway Company's Passenger Steamers in Use in the Channel Services, 1902.

Ship's name.	Year built.	Gross tonnage.	Shipbuilders.	Where built.	Length.	Beam.	Depth	Type of engines.	Boilers.	Working pressure	Passengers carried.	Service employed in.
					ft. in.	ft. in.	ft. in.					
Alberta	1900	1240	John Brown and Co.	Clydebank	270 0	35 6	14 6	Twin-screw 4 cyl. triple-expansion	2 cylindrical	200	710	Channel Islands
Alma	1894	1145	J. and G. Thomson	,,	270 7	34 0	14 6	,, ,, ,,	2 ,,	160	547	Havre
Columbia	1894	1145	,, ,,	,,	270 7	34 0	14 6	,, ,, ,,	2 ,,	160	547	Havre
Ella	1881	851	Aitken and Mansel	Whiteinch	235 5	29 1	14 2	Single-screw 2 cyl. compound	2 ,,	85	579	St. Malo
Frederica	1890	1059	J. and G. Thomson	Clydebank	253 0	35 1	14 8	Twin-screw 3 cyl. triple-expansion	2 ,,	160	712	Channel Islands
*Guernsey	1874	571·7	J. and W. Dudgeon	Poplar	195 9	26 0	13 4	Single-screw 3 cyl. ,,	2 ,,	180	381	Cherbourg
Hilda	1882	849	Aitken and Mansel	Whiteinch	235 6	29 1	14 2	,, 2 cyl. compound	2 ,,	85	576	St. Malo
Laura	1885	641	,, ,,	,,	207 0	26 8	13 2	,, 2 cyl. ,,	2 ,,	—	376	Cherbourg
Lydia	1890	1059	J. and G. Thomson	Clydebank	253 0	35 1	14 8	Twin-screw 3 cyl. triple-expansion	2 ,,	160	712	Channel Islands
†S. Western ...	1874	704·7	J. and W. Dudgeon	Poplar	222 3	27 1	13 5	Single-screw 3 cyl. ,,	2 ,,	160	476	St. Malo
Vera	1898	1136	Clydebank Engineering Company	Clydebank	270 0	35 1	14 5	Twin-screw 4 cyl. ,,	4 ,,	200	770	Havre
Victoria	1896	709·3	J. and G. Thomson	,,	220 1	28 1	16 3	,, 3 cyl. ,,	2 ,,	160	421	Jersey and France

NOTE.—The shipbuilders are the makers of the engines. * Re-engined by Day and Summers, Southampton, in 1889. † Re-engined by Earle and Co., Hull, in 1890.

* No. XIV. appeared May 23rd.

THE harbour of Tripoli has long been in need of improvement. It is both small and shallow, and the result has been that the trade of that Syrian seaport has been transferred in great measure to Beyrout. Twice during the last fifteen years there has been brought forward a project for making a large harbour and extensive wharves with an open roadstead at Tripoli. But these projects came to nothing. The trend of recent events in that region has aroused once more the attention of the Porte, and the project has come forward again. The authorities are convinced that the carrying out of the project is demanded, not only from political and commercial considerations, but also from military and naval standpoints. It is reported that the concession for executing the necessary work will be acquired by the Sultan's Civil List, and this fact is regarded as a proof that Turkey regards the possession of Tripoli as fully assured to it both by its own military forces and also by the assurances of certain foreign Powers, at least for a long time.

STEAM.

IN writing an answer to the article on steam which appeared in your issue of May 30th, I must first mention that I am writing in entire ignorance of the contents of Mr. Stromeyer's paper, "The Distortion of Boilers due to Overheating," read before the Institute of Naval Architects and referred to in that article; but I hope that that will not prevent me answering a few of the leading queries put forward in the article referred to.

Throughout the author is inclined to charge the scientific world with the neglect of the development of the theory of the steam boiler and the formation of steam in so far as it affects the practical work of steam production. In contrast to this neglect of the commonest and most useful of all substances, he says that "pages and pages are written about the ether, about the sun's corona, about a dozen recondite subjects. But no one in the present day has a word to say about steam, its nature, its mode of formation, what it really is." It is a most unusual charge—neglect of theoretical science—for a practical engineer to make, considering that so large a majority of "practical engineers" at the present time despise the introduction of any theoretical considerations into practical work, presumably through their want of higher education. Is this charge of neglect warranted by the facts?

It is certainly true that the production of steam has not been forwarded of late years by theoretical science to any appreciable extent; though the best methods of using it, when once produced, have been governed very largely indeed by purely theoretical considerations, which have given valuable information which could hardly have been gained by practical experience as it has been by experiments with the indicator.

But in looking for theoretical help it must be remembered what a difficult substance water is to experiment with. Its properties seem to be anomalous, and differ most unexpectedly from kindred substances. The question, therefore, resolves itself into an inquiry as to whether we are doing all we can to forward our theoretical knowledge of the conditions required for ebullition. It consists of a double duty, which we must acknowledge is being well performed.

First we have to teach young engineers all that has already proved useful in studying the subject, and if we look to our engineering colleges we shall find that this is being properly performed. The young engineer is taught the mathematics necessary for him to be able to calculate the potential and kinetic energies of systems of free particles under given conditions by the integral calculus. He is taught the mechanical and chemical bearings of the atomic theory—the dynamical theory of heat, and the kinetic theory of gases—in short, all the leading theories for the proper consideration of the subject in view.

Secondly, not only do we have to teach the theories which have proved useful in the past, but we have to press forward and extend that knowledge by present and future research. In this connection I may note that one of the last papers read before the Physical Society was on "The Ebullition of Rotating Water"—important, not because we shall expect to deal with rotary boilers in the future, but because it enables one to study the points of steam production with regard to the pressure gradient caused by the rotation. And, as an example of the study of the nature of water itself rather than its ebullition, I may mention that an exhaustive paper on "The Molecular Constituent of Water" was contributed in November, 1900, to the *Philosophical Magazine*, in which the subject was considered with the object of finding out the differences in the physical constitution of water in the three states, *i.e.*, as solid, liquid, and gas, and the explanation thereby of some of the well-known anomalies. It is therefore abundantly clear that the scientific world has not neglected theory in this case, but that the small advance made is due to the peculiar difficulties of the subject.

I will now proceed to study briefly the subject itself. Water and steam are supposed to consist of minute, hard, and perfectly elastic (spherical) particles; the difference between the solid, liquid, and gaseous state is supposed to be the variation of the density of the aggregation of these particles, and therefore the importance of the part played by mutual action and reaction. This mutual action is supposed to be very great during a minute portion of time before and after a collision, and to be negligible during the comparatively long time which lapses between the collisions of any two particles.

Such are the suppositions which a few years ago were supposed to offer a feasible explanation of the behaviour of gases, their expansion and contraction, as studied by Boyle and Charles, and their unlimited capability of expansion and diffusion as studied by Avogadro. Also,

the explanation of the latent heat of evaporation as found by experiment and change of entropy, as well as modern spectroscopic discoveries.

This is the point we start from, this is what we are taught in our science lectures, and it is from this point that we have to begin our research. But on examination we find that this is nothing more than a hopeless jumble of suppositions; one supposition has been added to another to explain the observed facts, besides the countless modifications—as the theory of oblique impact advanced by Clausius, and Maxwell's repelling forces, inversely proportional to the fifth power of the distances between the particles, and Stefan's assumption of molecular diameters inversely proportional to the fourth root of the absolute temperatures of the gases, and so forth. These latter merely strip the atomic and kinetic theories of their claim to simplicity, without adding one whit to their efficiency.

We have only to glance at the real meaning of the atomic and kinetic theories to see how fatally they are in contradiction to Descartes and Newton's theory of the conservation of energy, which is not only called an established fact, but is one of the foundation stones of these theories themselves, since the mechanical theory of the universe seeks to explain all phenomena by simple changes in the distribution of mass and energy, both of which are primarily supposed to be conserved. In the atomic theory, for instance, it is assumed that the particles are perfectly simple and perfectly hard, and hence from the first principles of mechanics, perfectly inelastic, since elasticity implies a compound body, the distances between whose parts can be varied against a force which tends to prevent such change of figure, and this is quite impossible with an atom as pictured by the atomic theory. Yet above I have had to put down "perfectly elastic" as one of the necessary suppositions, in order that we may hold a theory of constant collisions and still conform to the requirements of the law of the conservation of energy. Similarly, in the kinetic theory of gases the same law makes it necessary to suppose the molecules to be compounded of a number of atoms, which have to be so small in some cases to account for the observed value of the specific heat—whether reckoned at constant pressure or constant volume—as to be altogether discountenanced by chemistry.

Our material for the theoretical study of the formation of steam is, therefore, in a most ragged condition, and before one single step forward can be made we must realise that these theories are not the true explanations, but merely theories analogous in some ways to the true one, only stepping stones from which to start work. It is evident that these are temporary theories of a past generation already worn threadbare, and defaced by the requirements of more modern observation. The value of such a theory as this depends on the number of points in which it is analogous to the true explanation, whatever that may be. In the present case the theory presents the appearance of a parable which has fulfilled its primary object, but in which the analogy has been carried too far, making a great deal of patching necessary. The atomic theory has done the bulk of its duty, and people must be prepared to let it give place to a higher and, I believe, more complicated theory, in which the analogy to the true explanation is more perfect, so that it can better pass the exacting inspection of modern science. Such a theory has not yet been formed, but we shall not have to wait long before we have either a completed theory in which forced vortices in the ether replace the concept "atom," or else one in which the particles—at least five hundred times smaller than atoms—which apparently constitute matter in a fourth state, as found in very highly rarefied tubes under electric discharge, are considered to be the ultimate particles of matter and to constitute compound atoms.

So much for existing theories of the real nature of our heated steam, theories, I repeat, which are merely temporary stepping stones which give way the moment you put any real weight on them, because their foundations consist of contradictory terms.

In the case of liquid water the molecules are supposed to be still largely influenced by their mutual attractions, that is to say, the time of travelling along a practically free path is quite comparable with the time of travelling within the sphere of action of another molecule before or after collision. It is worthy of note here that the molecules are supposed to exist in perpetual motion, which is being constantly changed in speed and direction by mutual attractions, and is thus identical with our astronomical theory of the motions and orbits of celestial bodies, with this extraordinary inconsistency, that in one it is mathematically demonstrated that true collisions are impossible, and in the other constant collisions at all angles is a fundamental postulate! Now, in heating our water we are supposed to be endowing the molecules with a greater average speed—Maxwell's velocity of mean square. These, therefore, collide more violently, which at once sets up a strong repelling force, causing expansion, the molecules being more widely separated. In this condition it is obvious that the attraction at the surface will be very great towards the mass, and will not be balanced by any external attraction. Hence it is evidently very difficult for any molecule to escape from the liquid, since it acquires a large negative acceleration as it approaches the surface. The comparatively small number which escape owing to their enormous velocity overcoming this attractive force are supposed to account for evaporation taking place at all temperatures and increasing with the temperature.

And now comes the crucial point. A phenomenon takes place which the atomic theory cannot pretend to elucidate; we can only show that it has its analogies in other parts of physics. We are stretching the water, and we find that there is a definite law between the stress applied and the strain produced, which we can represent by a well-shaped curve. Suddenly we arrive at a point where energy is rapidly absorbed without apparently doing any work whatever. This continues for some time, and then a new state begins, and once more we can find a law between stress and strain, though now it is in the steam. This phenomenon exhibited so universally by matter has an analogy in the behaviour of certain solids subjected to considerable tension. I refer to the "yield point" of metals. Put a bar of metal into a large testing machine and subject it to tension. A curve can be automatically plotted between stress and strain, but presently a point will be reached when the bar will rapidly stretch, even if the load is kept constant—in fact, even if it is very considerably reduced—and this stretching may continue for several seconds. After this a regular law will again exist between stress and strain until the point of fracture is reached. In both cases at a certain point the law between stress and strain is mercilessly violated for a definite length of time, and without any apparent reason. All that science can say is that probably some molecular re-arrangement takes place.

In our steam we have, according to Clausius, about 75 thousand million billion molecules to the cubic inch at normal pressure, or at 100 lb. per square inch there would be about 487 thousand million billion molecules to a cubic inch, each one being about $\frac{1}{500000000}$ of an inch in diameter at a mean distance apart of $\frac{1}{2000000}$ of an inch, and each weighing about $\frac{3}{5} \div 10^{25}$ grammes, moving at an average speed of 1100ft. per second, and it has taken about 1181 thermal units per lb. to force these apart into this agitated state from the freezing point.

In the light of this theory we can now picture our boiler plate with water above and fire below. Heat will pass from the hot body—the fire—to the colder one—the water—and it is no simple problem when there is a boiler plate between them. The way the heat passes from the fire to the boiler plate is chiefly by radiation and absorption, the radiation taking place from the whole of the fire, hot gases, and sides of the fire-box, and in a far less degree by direct conduction from the hot gases to the boiler plate. We thus have the molecules of the boiler plate thrown into, and kept in, a violent state of motion. This can in turn be communicated to the water in two ways, by radiation and conduction. In this case, however, we have the same surface in contact with the water as is acting upon it by radiation, and hence it is probable that this action is chiefly one of conduction rather than radiation. If the water were really in absolute contact with the steel of the boiler plate this would be simple enough, but dealing with the conduction of heat from one conductor to another is just like dealing with the conduction of an electric current from one conductor to another, that is to say, we must see that there is good contact. This is generally obtained by pressing the conductors together and carefully cleaning them, and if this is not done there is considerable, often infinite, resistance at the junction, even when the bodies appear to be slightly pressed together, and in the last few years we have learnt to make use of such a contact in two of the most sensitive instruments we possess, the microphone and the coherer. In the normal state in these instruments there appears to be an insulating medium between the conductors, which may consist of a thin film of grease or other dirt, or even only of occluded air. It is the same with the surface of our boiler plate, where we are sure to find an important layer of grease or dirt as well as steam hindering the conduction of heat from the plate to the water.

It is thus of primary importance that the two surfaces of the boiler plate should be as large as possible, without much regard to the conducting power inside the plate, as Peclet and Wye Williams have shown, but for two totally distinct reasons: (1) the lower side, for the sake of greater absorption of radiant energy; and (2) the upper side, for the sake of lessening contact resistance between the plate and the water, so as to make conduction easier. Also, it is now more obvious why ebullition centres are formed, since, as in the electrical cases, sharp jagged edges tend to lessen surface resistance very much, and also clean spots on a new boiler will be natural ebullition centres for reasons explained above, and will be kept clean by the ebullition itself—grease them over and they will no longer form ebullition centres. There is also another most important cause for the formation of ebullition centres which I shall mention presently.

Now supposing we are dealing with atmospheric pressure—so as to be able to compare figures—each ounce of water represents about $11\frac{1}{4}$ thermal units at the boiling point, and an ounce of steam formed at the same temperature represents about $71\frac{1}{2}$ thermal units, the difference being the latent heat of one ounce of steam at atmospheric pressure, viz., $\frac{964 \cdot 3}{16} = 60\frac{1}{4}$ thermal units. The author of the article in question is wrong in supposing that this enormous quantity of energy is obtained from nowhere by an ounce of water instantaneously ($60\frac{1}{4}$ thermal units is equivalent to raising 1 ton to a height of 21ft. = 46,740 foot-pounds = 69×10^{10} ergs). This heat is gained just as gradually as the heat which warmed the water in the first place, but as soon as the temperature of 212 deg. Fah. is reached—if at 15 lb. per square inch—the heat is still gradually absorbed, but no longer as sensible energy, but as latent heat. Thus, in one minute it may have changed its heat from 200 deg. to 205 deg., in the next from 205 deg. to 212 deg., in the next from 212 deg. to 212 deg. + 1 thermal unit of latent heat, and so on.

And now comes in another curious unexplained phenomenon. When a large amount of the latent heat necessary for the formation of steam is obtained, the water has a strong tendency to become steam, and for this purpose snatches the remaining units from the surrounding water at the expense of its latent energy, if not its temperature. Thus, heat passes from a portion of water with an equivalent of fewer thermal units to a portion containing more thermal units, in order that this latter may complete its quantity for the formation of steam. Let me illustrate this rule by the phenomenon of the production of ice by cooling water. It is well known that pure still water can be cooled several degrees below 32 deg. Fah. without the formation of ice. We subtract a certain number of units until we have, say, water at 29 deg. Fah., and still we go on subtracting units without anything apparent happening. What are we doing? We are subtracting some of the latent heat of fusion, and some is still retained. It is a critical balance. Drop in some sand at one point, and ice will be immediately formed there. The formation of this ice means the delivery of the remaining units of the latent heat of fusion which are thus given to the surrounding water, which at once rises in temperature, because the water next it has managed to freeze. In the same way with steam, most of the latent heat is acquired gradually, and then one portion evaporates at the expense of the heat of the portions round it. It will now be understood that this is an important factor tending to prevent the even formation of steam all over the boiler plate and favouring ebullition centres.

Next as to the question of the bubble of steam gaining in weight as it rises through the water. I contend that the steam itself is likely to be slightly superheated and not the water through which it is passing, though this will be very nearly heated to the point of evaporation, since, due to the laws of convection, the water above will have just steamed up from the boiler plate below after heating. I do not mean that the water cannot be superheated, but that this does not afford an explanation of the phenomenon in question, since the quantity of heat obtainable would be insufficient to increase the size of the bubble appreciably. The water may or may not be slightly superheated, but it may very likely have got some of the latent heat necessary for complete evaporation. Hence it may only need a few units to make it evaporate. This cannot be obtained direct from the bubble of steam, but may well be obtained from the latent heat of the surrounding water, as explained in the case of the formation of the original bubble, and it is likely that this would be a tendency in the presence of the nucleus of steam already formed. Theories on the absorption of steam by water are very ingenious, and if such were the case the phenomenon under consideration could be easily explained. The latest acceptable theory on the molecular constitution of water is that steam consists of pure H_2O, termed hydrol, that ice consists of pure $(H_2O)_3$, termed trihydrol, and that water is a mixture of dihydrol $(H_2O)_2$ and trihydrol $(H_2O)_3$, the percentage depending in a simple manner on the temperature. Such a theory as this explains the anomalous thermal expansion, and obtains confirmation from optical refraction. It explains the melting of ice by pressure as the dissociation of trihydrol into dihydrol by pressure, and therefore its unexpected latent heat as latent heat of dissociation, and obtains confirmation from the observations of the unusual variations of the surface tension of water. It explains the unusual value of the latent heat of fusion, the specific heat and latent heat of evaporation, and also its unusual law of variation of viscosity and dielectric capacity—Röntgen—with variation of temperature. It is thus very strongly supported, and according to this theory there does not seem to be any reason why some of the dihydrol and trihydrol should not be dissociated into hydrol and absorbed by the remainder of these two—*vide Phil. Mag.* November, 1900. The picture of peas jumping up and down on a tambourine representing molecules of water above a boiler plate, and a thick cushion representing a film of grease, is attractive at first sight, but I should imagine that it is wholly incorrect. As I have stated above the conduction of heat from one conducting body to another is quite a different problem to conductance inside any body; it is a problem of the conducting properties of surfaces and surface films, and as in the case of the coherer of wireless telegraphy, is one that is at present little understood and of great delicacy. Thus the grease does not act so much as a mechanical cushion, but as a physical insulator. R. H. M.

THE INCORPORATED GAS INSTITUTE.

LAST week we gave a report of the presidential address of Mr. S. W. Durkin, M. Inst. C.E., and of the lecture delivered by Mr. James Swinburne, M. Inst. C.E., at the annual meeting of this Institute, held at Southampton on the 10th to the 12th inst. We will now refer to the ten papers which were presented at the meeting.

Perhaps the most generally interesting of these was one by Mr. Dugald Clerk, M. Inst. C.E., on "Large Gas Engines and the Gases used by them." The author described the four types of large gas engines now constructed on the Continent. Two types operate on the Otto or four cycle, and the remaining two on the two cycle which is identified with the author's name. The largest engine examined by him during recent visits to Germany and Belgium was one of 1200 brake horse-power, having four cylinders operating on the Otto cycle. It is at the Hoerde Ironworks in Westphalia, and was constructed by the Deutz Gas-Motoren Fabrik of Cologne. The fuel used is blast furnace gas containing 32 per cent. of carbonic oxide and $2\frac{1}{2}$ per cent. of hydrogen. The cylinders are 33in. in diameter, and have a stroke of 39·3in. The pistons work without water-cooling. The well-known engines built by Messrs. Cockerill at Seraing have larger cylinders; they likewise work on the Otto cycle. The largest is of 725 brake horse-power. It has a single cylinder, 51·2in. in diameter, with a stroke of 55·3in. The blast furnace gas used has a higher calorific power than that at Hoerde. It contains 7·0 per cent. of marsh gas, in addition to 27·9 per cent. of carbonic oxide, and 1·0 per cent. of hydrogen. Of the two types of two-cycle engines, one made by Messrs. Körting, of Hanover, operates precisely on the original Clerk cycle of 1881, but is double-acting. The author inspected a 500 horse-power engine of this type in work at Duisberg. It has one motor cylinder, 24·8in. in dia-

NEW ELECTRIC GENERATING STATION AT SHOREDITCH

(For description see page 602)

meter, and 43·3in. stroke. The other type of two-cycle engine is the "Oechelhaeuser," made by the Deutsche Kraftgas-Gesellschaft, of Berlin, of which many examples are at work. There are two working pistons, which move in opposite directions in one working cylinder open at both ends. The cylinder is without ports or irregularities of any kind, and hence is admirably adapted to deal with blast-furnace gas, which can only with extreme difficulty be entirely freed from dust. The author found that the Oechelhaeuser engines worked with great smoothness, and were very certain in all the valve operations. They are being constructed up to 1000 horse-power in one cylinder, and up to 2000 horse-power with two cylinders. A 600 horse-power engine of this type has operated continuously since January, 1899, at Hoerde.

The author next referred briefly to large gas engines in this country, mentioning the 400 horse-power Crossley Otto cycle engine, and the 500 horse-power Premier engine. Little use, however, has yet been made of blast-furnace gas for engines in this country, probably because fuel is cheaper here than on the Continent, and there is less incentive to utilise waste fuels. Dowson gas is generally used here for the larger gas engines, and, in the author's opinion, is unlikely to be ousted by Mond gas, even if the latter can actually be supplied at the promised 2d. per 1000 cubic feet. Gas-producing plant is now being made, by Messrs. Crossley among others, to supply gas engines without the intermediary of the cumbrous and expensive gasholder. The author thinks, however, that if coal gas, having a heating value of 600 B.T.U. per cubic foot, could be distributed for about 1s. per 1000 cubic feet, it would compete very successfully with Dowson and similar gases for the supply of heat and power. Gas engines up to 100 horse-power would commonly use such coal gas at that price, and an enormous expansion would ensue in the gas and gas engine industries.

Another interesting paper was one by Mr. W. D. Child, of Romford, describing the application of two Laval steam turbines for driving the fans required for producing the air-blast for carburetted water gas plant. Mr. Child is very highly pleased with the performance of the turbines, on account of their simplicity and high efficiency. He adopted them in preference to reciprocating engines, with a view to avoiding excessive vibration in an engine-room erected on old walls, which were well able to stand the weight of the engines, but were likely to be affected by the vibrations of high-speed machinery driven by reciprocating engines. He found that they not only fulfilled his expectations in this respect, but afforded many collateral advantages. He suggested that they might be employed equally well for driving exhausters.

Mr. T. G. Marsh, of Manchester, described, in a paper entitled "A New System of Gas Measurement," a new rotary gas meter, in which the stream of gas propels vanes attached to a shaft connected to a counter. The difficulties in constructing a meter on this principle lie chiefly in properly guiding the gas on to the vanes, and in reducing the friction of the shaft to a minimum. When only a relatively small quantity of gas is passing, a meter of this type does not register correctly, hence its scope is greatly curtailed; but it should serve well to control the working of plant on a gasworks. It is, of course, much more compact than the ordinary wet station gas meter of equal capacity.

Mr. J. P. Leather, of Burnley, described methods he has adopted for the valuation of oil for gas making. He was led to investigate the matter owing to a purchase of Borneo oil for use in a carburetted water gas plant having given unsatisfactory results. But we may remark that no gas manager should ever be persuaded to buy gas oil without having a sample examined with a view to determining its fitness for gas making. The trifling cost of such an examination is but a thousandth part or so of the loss which may result from an attempt to use unsuitable oil. We are surprised that an engineer of Mr. Leather's reputation should have ever attempted to dispense with a proper examination of gas oil prior to purchasing. Most gas engineers, however, are too fully occupied with engineering work proper to spend time on the elaboration of a scheme of oil-testing which may well be left to the chemists. Actually, Mr. Leather had to have the assistance of a chemist in his investigations, and the paper would have come more appropriately from the latter, as it was devoid of engineering matter.

A useful little paper on "Efficiency and Economy in Gas Distribution" was contributed by Mr. Walter Hole, of Leeds. He referred to the enlargement of distributing systems necessitated by the continuous increase in the demand for gas, and gave a short account of the difficulties which had to be overcome in laying a 36in. main recently in an important thoroughfare in Leeds. He then discussed the economy achieved by the use of long pipes in main laying, and afterwards recommended the making of joints with an alloy consisting of 28 per cent. of antimony and 72 per cent. of lead run at a temperature of about 365 deg. Cent. By this means "setting-up," which in many positions is difficult and expensive, is avoided, but the alloy, of course, costs more than lead. He made a few further comments on incidental points in main laying and distribution.

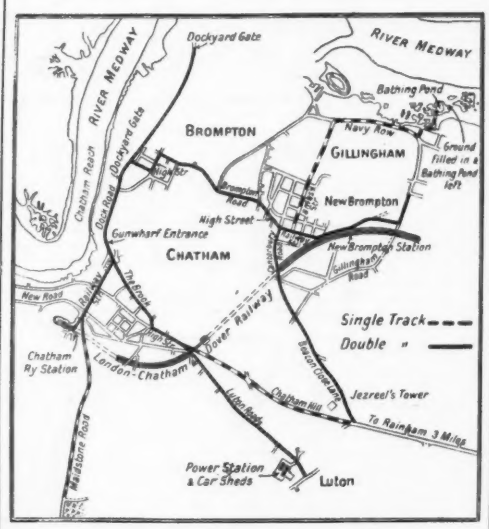
Three papers of somewhat subsidiary importance from an engineering standpoint were read on the following topics:—"Maintenance of Incandescent Gas Burners by Gas Companies," by Mr. N. H. Humphrys, of Salisbury; "The Fittings Business as an Aid in the Sale of Gas," by Mr. R. Watson, of Hertford; and "Automatically Lighting and Extinguishing Public Lamps," by Mr. W. R. Mealing. A paper by Mr. R. G. Shadbolt, of Grantham, advocated Sunday rest for gasworkers, ostensibly on grounds of expediency and economy. Apart from moral and sentimental considerations, it is a question whether work would not be better performed in all gasworks under a uniform system of one day's rest in seven; that is to say, that on each day of the week one-seventh of the workers would be making holiday. Under such a system all would get a reasonable rest, and there would be no question of enhanced pay for Sunday work, which is a fruitful source of trouble in works where Sunday rest is practised as far as possible.

The last paper to which we have to refer was one by Mr. C. E. Jones, Assoc. M. Inst. C.E., of London, which aimed at answering the question, "Is the Gas Capital in England and Wales Excessive?" The author had compiled statistics of the capital burden per unit volume of gas sold, and per consumer, for about 400 gas undertakings in the United Kingdom not owned by local authorities. He had classified the undertakings according to size, and gave the average results for each class. In conclusion he submitted that the capital of gas companies was, speaking generally, higher than was warranted by fact, and that it had not its equivalent in works, and should be reduced. About 100 companies had abnormally high capitals. He suggested that parliamentary powers should be sought for applying half the surplus profits of an undertaking to a sinking fund, with a view to thus securing relief from over-capitalisation. He concluded with a reference, which was somewhat beside the question under discussion, to the comparatively high degree of purity of London gas. He thought this an expensive luxury, which gas consumers in the metropolis could forego with advantage. But he did not actually state what is the extra cost per 1000 cubic feet of the purification of gas in London, as compared with other large towns where a less high degree of purity is maintained. As a matter of fact, the additional cost is practically *nil*, and does not warrant an increase of ¼d. in the selling price of 1000 cubic feet of gas. In following the fashionable lead of abusing London gas regulations, we think Mr. Jones must have spoken without reference to the actual statistics.

The technical proceedings which we have now briefly reported rendered this year's meeting more satisfactory than those of recent years, though the attendance of members was not quite so large as usual. The private business transacted included the election of Mr. Andrew Dougall, of Tunbridge Wells, as president for the ensuing year, and the passing of resolutions which bring the Institute a stage nearer amalgamation with the Institution of Gas Engineers. If the Councils of the two bodies now proceed to dispose of the remaining obstacles to amalgamation in a conciliatory spirit, it is possible that the two bodies may be united at a not far distant date.

ELECTRIC TRAMWAYS AT CHATHAM.

On Tuesday last the formal opening of a system of electric tramways for Chatham and district took place, when a number of gentlemen made a trip from the power-house at Luton to the Chatham Town Hall. The system has been constructed by the British Thomson-Houston Company, Limited, for the Chatham and District Light Railways Company, and has at present a length of about 8½ miles, of which about 2¾ miles are single line. The district served will be seen from the accompanying sketch. Owing to the narrowness of most of the thoroughfares traversed the gauge has had to be restricted to 3ft. 6in. The contract for the complete equipment was let to the above company in June, 1901, the work including all buildings and plant, permanent way, overhead line, cars and motor equipment. The design and construction has been under the personal supervision of the company's chief engineer, Mr. A. H. Walton. The building has been carried



CHATHAM ELECTRIC TRAMWAYS

out by West Brothers, Stroud, J. W. Nash and Son attending to the architectural details and supervision of building. The buildings comprise:—Car sheds and repair shops; main generating station; tank house, cooling pond and pump, offices, &c. The car sheds proper are laid out for fifty cars in two bays each 38ft. 10in. wide by 193ft. 6in. long. One bay is arranged with four tracks having inspection pits running the whole length, the rails being laid on longitudinal sleepers. The other bay is arranged for four tracks, the rails resting on a concrete bed.

At the end of the car sheds is a set of workshops, consisting of paint-shop, machine-shop, and general repair shop, these being equipped with the necessary tools and appliances for carrying out this work.

The generating station is arranged in two sections, one for the engines and generators with auxiliary plant, and the other containing the boilers. The building is constructed substantially of brick on concrete foundations. Adjacent to the building housing the fuel economiser in connection with the boiler plant, and attached to this is a flue and brickwork pedestal for carrying a steel plate chimney, 150ft. high, from the underside of the cast iron base plate by 7ft. 9in. diameter at the top of the shell, and, when lined, having a clear internal diameter of 7ft. The base plate is made of cast iron in sections, bolted together on the inside and prepared with holes for the holding-down bolts securing the same to brick foundation. The shell is made of steel plates, lap-jointed and riveted, tapering upwards, and finished with an ornamental cap at the top.

The interior of the chimney is completely lined with fire brick specially moulded to suit the radius. The chimney was supplied and erected by Head, Wrightson and Co., Limited, of Middlesbrough. At the rear of the generating station a tank-house is built for carrying the main storage tank, the interior of the house being utilised for stores. A cooling pond, built of brick on a concrete bed, is provided for the supply and storage of condensing water, and adjoining this is a brick sump for blow-off water from the boilers, so as to allow the same to cool before entering any drains.

The boilers are four in number, of the Lancashire type, each 30ft. long and 7ft. diameter, with two flue tubes, each 3ft. 9in. in diameter, and are made by Yates and Thom, Blackburn. The working pressure is 160 lb. per square inch, and the evaporative duty 5900 lb. of steam per hour. Each boiler is fitted with Vicars stokers, driven from an overhead shaft by means of an electric motor. A fuel economiser is provided, consisting of 288 pipes, $4\frac{5}{16}$in. diameter and 9ft. long, in thirty-six sections, each eight pipes wide, suitable for a working pressure of 160 lb. per square inch, and made by Lowcock and Co., Shrewsbury. The plant for cooling the circulating water in connection with the surface condensers comprises fifty of Gjers and Harrison's patent simplex spraying nozzles, arranged in two sections of twenty-five nozzles each.

A plant by the Desrumaux's Water Softener and Purifier Company, Limited, is erected for the purpose of softening the water, and so reducing the hardness to a degree suitable for use in connection with the steam boilers and other parts of the plant. The condensing plant includes one Wheeler surface condenser, with 1200 square feet of cooling surface, and is fitted with a combined air and circulating pump operated by a steam cylinder, the pistons being all mounted on one rod.

The main generating engines are three in number, of the horizontal compound tandem type, each developing normally 320 indicated horse-power, and a maximum of 480 indicated horse-power, when working with steam of 150 lb. pressure, and running at 100 revolutions per minute, and working condensing. Each engine is arranged to drive a 200-kilowatt electric generator mounted directly on the main shaft.

The makers of the engines are Yates and Thom, Blackburn. The cylinders are 15in. and 29in. diameter by 36in. stroke, steam jacketed and fitted with valves and gear of the Corliss pattern, arranged so as to automatically control the speed within 2½ per cent. above and below the normal speed of 100 revolutions per minute. The crank shaft is made of open-hearth steel, 16½in. diameter in the body. At one end of the shaft a crank of the counterbalance disc type is placed, fitted with a steel crank pin 6¾in. diameter by 8in. long. At opposite end of shaft, and adjacent to the fly-wheel, provision is made for mounting the generator. The fly-wheel is 15ft. diameter, and weighs 20½ tons.

The three continuous-current generators, each having a normal full-load capacity of 200 kilowatts at 550 volts when running at a speed of 100 revolutions per minute, are of the railway type, and are direct connected to their respective engines. They are of the slotted core type with carbon brushes, and the fields have eight removable poles, the field frames being divided horizontally. One series-wound booster is employed, consisting of a 500-volt shunt wound motor, driving a series wound generator, having a normal full-load capacity of 17½ kilowatts at 50 volts. The switchboard consists of panels of slate 2in. thick, with a ¾in. bevel on all front edges. Each panel is 90in. high, built up in two pieces, the upper part being 62in. high and the lower or sub-base 28in. The panels are assembled on vertical angle irons with nickelled bolts and washers, the adjacent panels butting together, rendering the framework invisible from the front. Floor brackets are provided, and tie rods for supporting the board from the wall.

The station lighting set comprises one Belliss standard engine capable of developing 112 brake horse-power when running at a speed of 400 revolutions per minute, with a steam pressure of 150 lb. per square inch and working condensing. The engine is arranged to drive a 75-kilowatt electric generator—mounted on a combination bed-plate—which will be used for supplying power for lighting the sheds and offices, and for shunting cars after the main sets have been shut down.

Double overhead line equipment has been carried out along the whole of the routes, together with single lines over the various tracks in the car sheds and in the yard of the power station. The trolley wire, of 00 gauge, is of hard drawn copper, having a diameter of about ·364in. Side pole and bracket construction has been used throughout, except in a few places where spans are erected. The bracket arms vary from 8ft. to 18ft. in length. The overhead line is divided into ½-mile sections by section insulators; guard wires have been erected where necessary. The line and return feeder cables, together with cables for affording telephone communication between various points of the routes and the power station, and for measuring the drops between different points of the rail return, in accordance with the Board of Trade regulations, have been supplied and laid by W. T. Glover and Co. All the cables are made up of stranded copper conductors, insulated with impregnated paper and lead covered, and are laid in a wooden trough filled up with insulating compound, suitable distance pieces being employed. The whole of the cables are laid, wherever practicable, under the footways. The line feeders are four in number.

The contract for the permanent way was sub-let to Mr. Osman, of Southampton. The rails are of the girder type, 6in. deep, weighing 92½ lb. per lineal yard. They were supplied by the Barrow Hematite Steel Company in 45ft. lengths, with a proportion of 30ft. and 36ft. lengths. There are five tie-bar holes in 45ft. rails, and proportionately in the shorter lengths. The fish-plates are 28in. long, weighing 44 lb. per yard, and are secured with six 1in. bolts and nuts. Sole-plates are fitted under all rail joints, and held securely in place with eight bolts and nuts. The tie bars are of flat mild steel, provided at each end with a round shank, screwed with ⅞in. Whitworth thread and with two nuts, and of suitable length for a gauge 3ft. 6in. Drain rail boxes are provided where necessary. All points and crossings are of crucible cast steel made by Hadfield's Steel Foundry Company, Limited. Each rail joint is bonded with two Chicago bonds, with cross bonding at suitable intervals.

The company starts service with twenty-five cars. The bodies have been built by G. F. Milnes and Co., and are of the double-deck type, with reversed staircases, the seating capacity being 26 outside and 24 inside. They are mounted on Brill 6ft. wheel base trucks, fitted with Peckham life-guards and slipper brakes. The equipment consists of two motors of the G.E. 58 type, and B. 18 controllers with rheostatic brakes. The trolley is fixed centrally on the top deck.

Many difficulties have been met with in the laying of the permanent way, owing to the narrowness of the streets and the peculiar conformations of their surfaces; but the contractors appear to have effectively overcome all these, while the overhead construction has been carried out as unobtrusively as it is possible in a town offering such peculiar conditions.

Mr. H. W. Miller has had charge of the whole of this contract, under Mr. A. H. Walton, whilst Mr. E. T. James has acted as resident engineer-in-charge of power-house plant, cars, and overhead line, and Mr. W. H. Davis has superintended the track work and bonding.

THE SHOREDITCH NEW GENERATING STATION.

WHEN the existing electric power station of the Shoreditch Borough Council was opened by Lord Kelvin in June, 1897, it contained three generators each of 165 kilowatts, and three with an output of 70 kilowatts, and it was supposed that this plant would be quite sufficient to supply the needs of Shoreditch from an electricity point of view for many years to come. From the moment, however, that the service was effected the demand has steadily and continuously increased, so that for some time past the original generators have been supplemented by others of the largest size possible to get into the remaining space in the original engine-room, and it became necessary for the Council to consider seriously the necessity of erecting a new power-house on a larger scale than the former one.

A suitable site having been found at the corner of Whiston-street and Bath-place, Haggerston, on the banks of the Regent's Canal, the Borough Council instructed their consulting electrical engineers, Messrs. Kincaid, Waller and Manville, to prepare a comprehensive scheme for the erection of a new power-house which would provide for all the possible future needs of the district. The scheme proposed by them has been adopted by the Council, and the works, of which the following is a description, have been completed under the supervision of Messrs. Kincaid, Waller and Manville and Mr. C. Newton Russell, the borough electrical engineer.

The design of the new power-house, which was formally opened last Monday, is on a large scale, although only two units of generating plant have at the present been installed, but the engine-house and boiler-house are capable of enlargement to an extent that will allow the present output being multiplied many times—to such an extent, in fact, that it is inconceivable that the demand for an electricity supply in Shoreditch can in the future exceed the facilities offered by the Whiston-street site installation.

Generating station.—The generating station occupies a site of about 19,800 superficial feet in area at the corner of Whiston-street and Bath-place, Haggerston, with frontages to the Regent's Canal and the Haggerston Basin, enabling coal to be delivered by barge, and providing a supply of condensing water. The buildings consist of a boiler-house, 68ft. by 62ft., with pump-room adjoining; engine-house, 78ft. 6in. by 59ft. 6in., with basement, into which the condensing water and other pipes are taken. A subway for the cables leading from this basement to a chamber under the pavement in Whiston-street is provided for the feeder cables leaving the station. A transformer room, containing the continuous-current transformers for supplying the network in the neighbourhood of the generating station, is provided, with workshop and stores also adjoining the engine-room.

The switchboard gallery extends the whole length of the engine-house, and is 11ft. above the floor level. Chambers are provided below the gallery for the reception of the shunt regulating and other resistances, and for the accommodation of the cables proceeding to the machines and circuits. A room for the engineer-in-charge at this level leads directly on to the gallery. A handsome room, with ante-room, having separate approach, is provided for the members of the Committee.

Accommodation for a resident engineer has been provided in a small house at the corner of the site, with entrance from Whiston-street. Separate rooms are provided for the men employed in the engine-house and boiler-house respectively, and each have their necessary lavatory accommodation. The chimney shaft, 180ft. in height, with an internal diameter of 10ft. at the top, is placed in the yard at the rear of the site, and adjacent to the canal. The buildings are faced externally with picked Fletton bricks, relieved with red Leicestershire bricks. The engine-house is faced internally with Fletton bricks, having a glazed brick dado and strings running round the walls, with glazed brick arches to the openings. The floor is laid with vitreous mosaic. The foundations of the chimney shaft and the main wall of the buildings are taken down to the London clay, a depth of about 21ft. The contractors for the buildings are Johnson and Sons, of Leicester, and for the chimney shaft Storrs and Son, of Stalybridge.

Boiler-house plant.—The boiler-house plant consists of four water-tube boilers of Messrs. Babcock and Wilcox marine type, having solid drawn steel tubes. Each boiler has a heating surface of 2720 square feet, and is fitted with an economiser containing 350 square feet of heating surface, making a total heating surface in the four boilers of 10,880 square feet, and in the four economisers of 1400 square feet, thus making a total heating surface in the four boilers and four economisers of 12,280 square feet. It will be noted that the floor space occupied is very much less than with boilers of the land type. Three of the boilers are hand fed, having an ordinary grate area of 73½ square feet, which makes a total grate area in the three boilers of 220½ square feet. The remaining boiler is fitted with a double 4ft. patent chain grate stoker made by Babcock and Wilcox. The grate area of this boiler is 68 square feet, the total grate area in the four boilers being therefore 288½ square feet. These four boilers combined will produce about 50,000 lb. of steam per hour, and are arranged alongside one side of the boiler-house, the space on the opposite side of the boiler-house being available for the accommodation of additional boilers whenever they are required. The products of combustion are conveyed from the boiler to the chimney through flues constructed of steel placed overhead. The flues are lagged externally by magnesia, which is held in position by means of external plates. A chamber has been provided at the base of the chimney shaft to which the main flue is connected, and is so arranged that induced draught apparatus can be added subsequently.

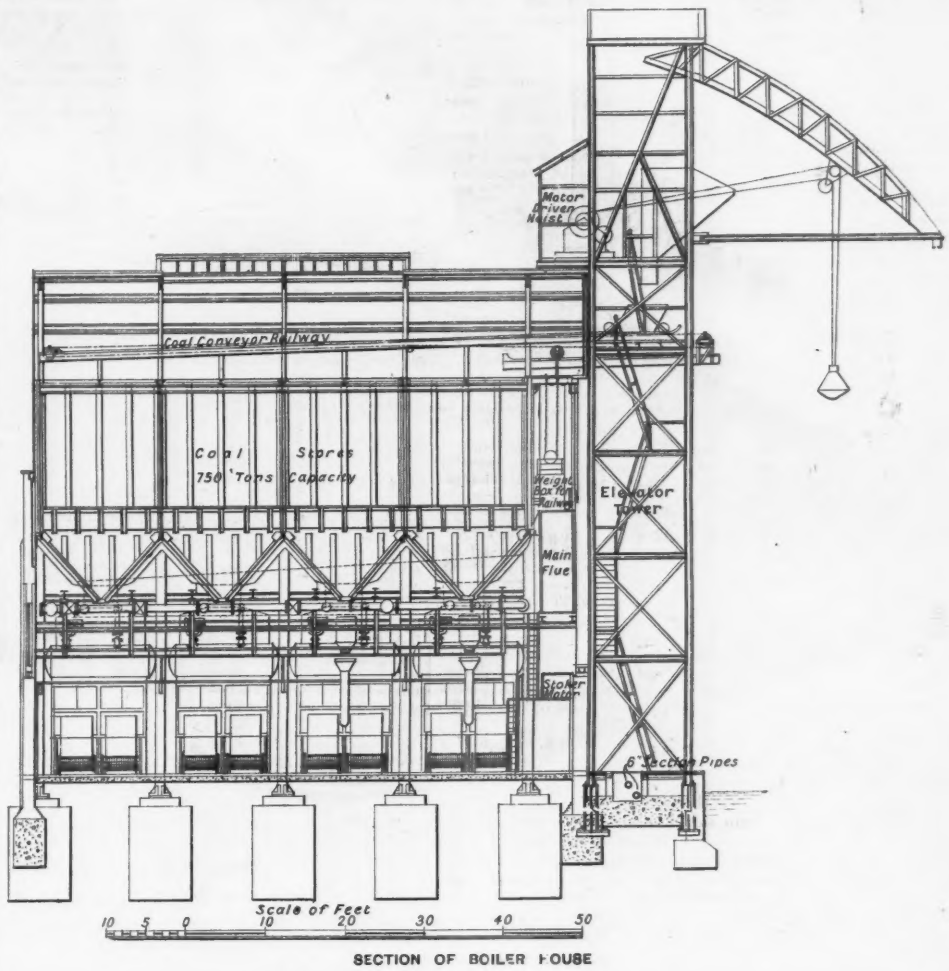
The boilers are supplied with coal from an overhead coal store having a total capacity of 750 tons, erected on steel stanchions above the stoking place in the centre of the boiler-house. Pockets with sloping sides are provided in the bottom of these bunkers to facilitate the discharge of the coal to the boilers. A special feature about the boiler-house is the arrangement by which the coal is lifted from barges on the canal alongside the generating station, conveyed to the bunkers and afterwards to the boilers. The coal is lifted from barges by means of a hinged grab or shovel of ½-ton capacity, which is projected from a boom of parabolic form extending over the canal. This apparatus is situated at the top of a tower constructed of steel work placed near the edge of the canal at the end of the boiler-house. A parabolic form of boom enables the load to be lifted vertically until it reaches its extreme elevation, when an inward movement takes place, at the end of which movement the coal is dumped into a hopper and delivered, through a regulating duplex valve, into an automatic wagon, which, after being filled, is released and run over the top of the bunkers, dumping the coal at any point where it is required. The hoist is driven by means of two electric motors of the enclosed type, supplied by the Westinghouse Company, the space being regulated by a series parallel controller. Each of the openings at the bottom of the pockets beneath the coal bunkers is provided with regulating valves, one being placed opposite the centre of each boiler, which enables the flow of the coal to be controlled. The coal is delivered by means of these valves into a hopper having a weighing apparatus, so as to register correctly the amount of coal delivered to the boilers. At the present, the coal for the boilers which have not been fitted with mechanical stokers will be delivered on the floor in front of the boilers as the fireman requires it. In the case of the boiler fitted with a mechanical stoker the coal will be delivered directly into the hopper in connection with the stoker. The peculiar feature of this automatic railway consists in storing sufficient energy required by the loaded car descending an inclined track, the energy being utilised to return the empty car back to the place from whence it started after the load has been discharged. The loaded car runs down the inclined track, and when it has reached the end of its journey it has raised a counterweight a certain height by means of a cable, which the car picks up while running down the track. The weight rises only a limited distance, but when the car has dumped its load of coal, which is from 20 cwt. to 25 cwt., the weight falls, and whilst so doing pushes the car a certain distance back up the track, the momentum gained being sufficient to carry the car the remainder. One man only is needed to operate the railway, who starts the car when filled, but does not accompany it. The car runs down the inclined track, dumps its load, and hands it automatically to the workman. It runs with great rapidity, making the trip of 100ft., dumping its load, and returning in about thirty seconds.

Gangways are provided in the boiler-house for access to the fittings in front of the boilers and to the stop valves on the main steam range. The coal handling apparatus has been supplied by Babcock and Wilcox, being of the Hunt Company's special design. The whole of the steel work, comprising the coal storage bunkers, elevator, tower, and roof for boiler-house, together with the overhead flues, have been supplied by Peirson and Co., St. Dunstan's-hill, E.C.

The feed pumps are three in number, two of them being capable of delivering 2500 gallons per hour to the boilers, and the third 5000 gallons per hour. They are of the G. and J. Weir Company's make, and deliver to the boilers through the feeds, which are in duplicate, each main being provided with a separate filter and water meter. The suction pipes to the feed pumps are also in duplicate, one pipe being connected to the overhead feed storage tank, the other pipe being connected to the hot well. The feed-water storage tank is constructed of cast iron plates, and is capable of holding 12,000 gallons of water. This tank is divided into two sections to enable either section to be cleaned without interfering with the continuity of the supply of water to the pumps. The hot well consists of a galvanised iron tank having a capacity of 1500 gallons. A special feature in connection with the hot well is that it is placed upon a weighbridge, so as to provide a ready means of measuring the water discharged from the air pump when carrying out tests on the plant.

The main steam pipe is arranged in the form of a ring placed in the boiler-house, the main pipe being 10in. in bore, and constructed of mild steel, with the flanges shrunk on and riveted. Jointing is avoided as much as possible, and with this in view the branch connections are made by means of flanged outlets of mild steel, riveted on to the main pipes. The ring is divided up into sections by means of straight-through valves, so as to limit the effect of any failure to the particular section of the ring affected. All valves are of the straight-through pattern, with cast steel bodies. The whole of the steam and feed piping, feed pumps, storage tank, &c., have been supplied by Acton and Co.

It will be seen from the above description that there are some essentially novel features in the latest undertaking of the Shoreditch Borough Council. The marine type of Babcock and Wilcox boiler has, we believe, never before been utilised for service on land, and are expected to give efficient results, the comparatively small ground space occupied by them in comparison with their steam capacity is held to make them eminently suitable for a large electric generating station. The automatic railway for handling and trimming the coal in the overhead bunkers is also a novel feature in this country. It will be noticed that the system of supply adopted for the new generating station is similar to that supplied by the Council in their first generating station, *i.e.*, high-pressure continuous current being generated at the power-house at about 1100 volts, delivered to sub-stations located in various portions of the area, where the current is transformed down to the pressure required for the service to consumers' premises through continuous current motor transformers, consisting of machines with one field and a double-wound armature. The distribution from the sub-station through the streets to consumers' premises is on the two-wire system.



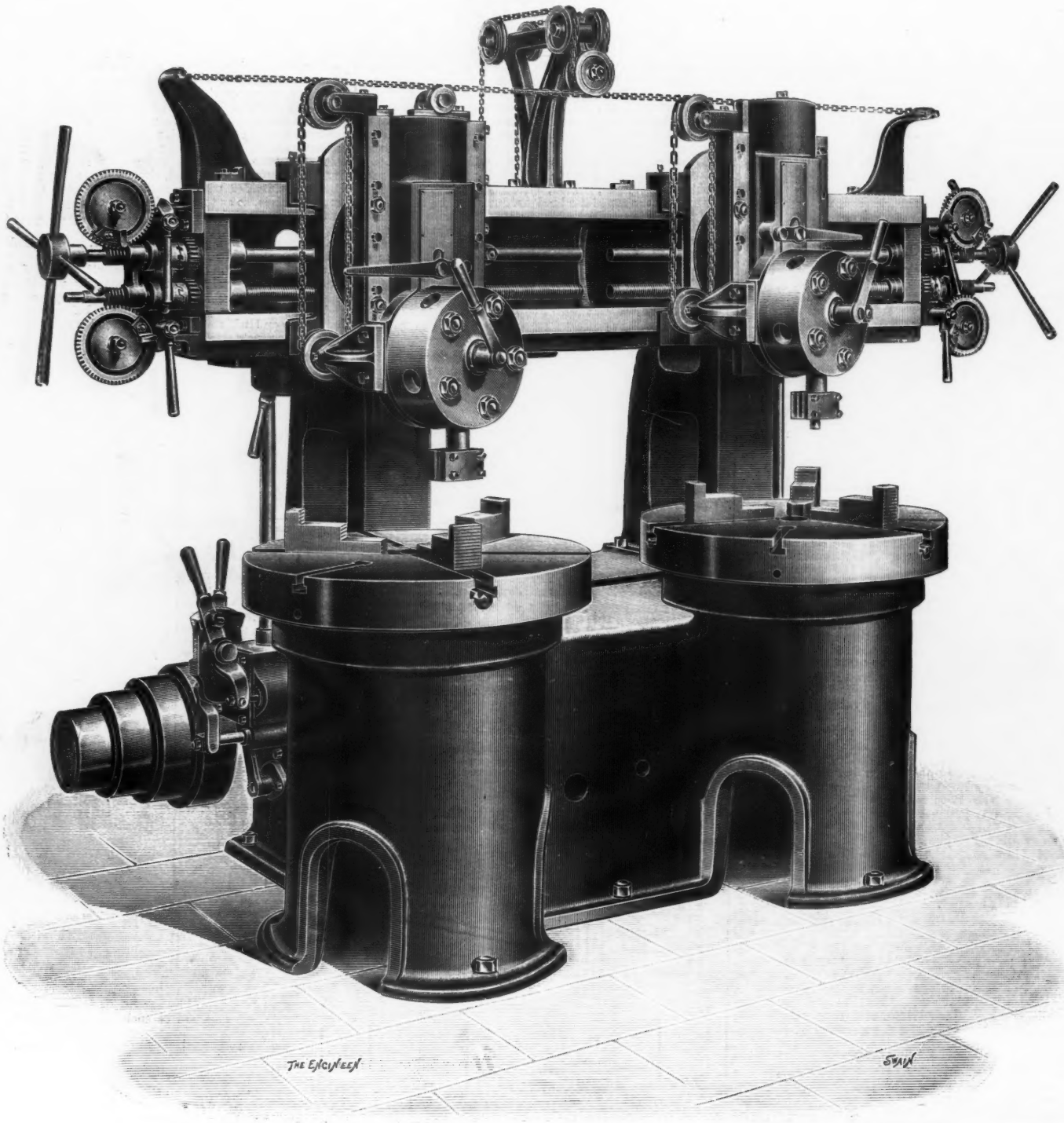
SECTION OF BOILER HOUSE

Engine-house plant.—The engine-house consists of two vertical slow-speed Corliss compound steam engines, each direct-coupled to a continuous-current dynamo of 800-kilowatt capacity. Each engine is provided with its own condensing plant, consisting of surface condenser with air and circulating pump, driven direct from the main engine. The engines are designed to run at a speed of 90 revolutions per minute, and are capable of developing from 1300 to 1400 indicated horse-power. The diameter of the high-pressure cylinder is 24½in., and the diameter of the low-pressure cylinder is 53in., stroke 42in. The crank shaft, generator bearings, connecting-rod end and slides are provided with forced lubrication under pressure, oil pumps being provided for this purpose working from the crank shaft. The main standards are suitably enclosed to prevent oil splashing about, large doors and movable casings being provided to give access to the working parts. Both high and low-pressure cylinders are provided with automatic Corliss trip gear, controlled by the governor. The governor is of Whitehead's isochronous type. In addition to the ordinary

DOUBLE BORING MILL

MESSRS. WEBSTER AND BENNETT, COVENTRY, ENGINEERS

(*For description see page* 605)



governing an emergency governor of the inertia type is provided. The fly-wheel, weighing about 32 tons, is of the built-up type, with steel tension arms. Steel rings are shrunk on the hub as an additional safeguard. Ladders and staging are provided for access to the valve gear and other working parts. The generators are of the multipolar type, made by the Westinghouse Company.

The armature and commutator are built upon a ventilating cast iron sleeve, forced on the engine shaft under pressure. The field castings are divided in a vertical plane, and are mounted on cast iron slot-plates. The rated load of each of the machines is 730 ampères and 1100 volts. The machines, however, are designed to carry an overload of 50 per cent. for two hours if necessary above this rating. The armature is of the slotted drum type, having a multiple winding so arranged that the circuits will not become unbalanced by a slight displacement of the armature from the centre of the fields. The brushes are adjustable by means of a hand wheel and worm gear, and the arms carrying the brushes are supported at the end next to the field casting, so as to leave the commutator free from obstruction. The brushes are of carbon.

The arrangements for ventilation are very perfect in this type of machine, and open ducts are provided for this purpose throughout the armature to the spider core and windings, the design of the spider being such as to set up a forced current of air through these ventilating spaces. The exhaust steam from each engine passes through an old separator on its way to the condenser. The condensers each have a cooling surface of 2700 square feet. The air and circulating pumps are driven by means of levers from the high-pressure cross-head. The air pumps are of the Edwards single-acting type, and circulating water pumps being of the double-acting type. The circulating water is taken from the basin in connection with the Regent's Canal, and is returned through pipes down Bath-place into the main canal. An alternative exhaust to atmosphere with automatic release is provided. The engines have been manufactured by the Wallsend Slipway and Engineering Company, and they also supplied the generators, together with exhaust and water pipes in connection with the engines and condensers.

As previously mentioned, the switchboard is placed on a gallery which runs the whole length of the engine-room, the high-tension portion being placed at one end, and the low-tension at the other. The high-tension board is divided into the following sections:—(1) High-tension dynamo board, comprising positive and negative dynamo panels for each generator, with paralleling panel in the centre. (2) High-tension trunk feeder board, comprising positive and negative panels for two feeders. (3) High-tension transformer board, comprising panels for four transformers. (4) Arc circuit board, with provision for three arc circuits. The low-tension board consists of positive and negative feeder panels for six low-tension feeders. This switchboard will be used in connection with the continuous-current transformers, and for supplying the network in the neighbourhood of the station, and is arranged with plug system, whereby any transformer can be plugged on to any low-tension feeder. Both high and low-tension switchboards have been supplied by Messrs. Cowans, of Manchester, the high-tension board being of their special design, the high-tension switches being mounted on horizontally crossed plates, and the whole being mounted on an iron frame, which is placed against the face of the wall without the necessity of leaving a space behind for access to the working parts. All the main high-tension switches are provided with reverse current cut-outs of the Andrews type, and the switches can also be opened by means of a hand trip gear. These switches break through about 1in. of water. The instruments are of Evershed and Vignoles' make, with the exception of the volt meters, which are of the Ayrton and Mather multi-cellular type. The recording instruments are by Elliott Brothers. A special feature in connection with the design of the switchboard is the camber that is provided below the gallery to contain the various resistances and high-tension omnibus bars.

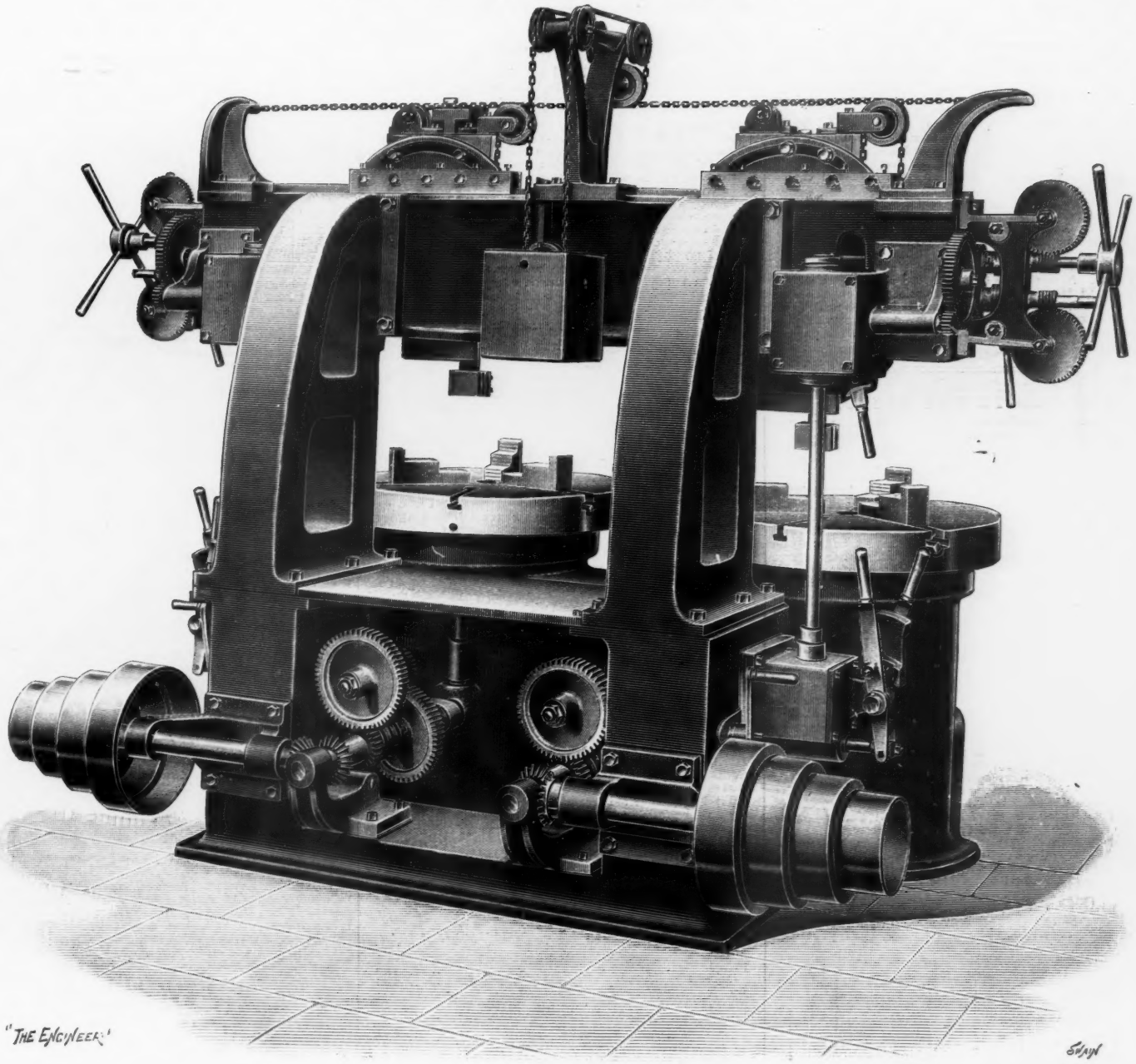
The spindles for working the regulating resistances are brought up through the floor of the gallery, and are operated from a convenient height, cast iron pillars and hand wheels being provided. A light gangway is provided in the chamber below the board for convenient inspection of the various regulating switches and resistances. The high tension omnibus bars which are carried in the chamber below the gallery, as previously mentioned, are supported on oil insulators.

In addition to supplying the switchboards for the Whiston-street generating station, Messrs. Cowans have supplied trunk feeder panels at the receiving end of the trunk feeders at the old station in Coronet-street, and have supplied the additional switch gear for the two sub-stations at Reeves-place and Evelyn-street respectively.

THE Bermuda floating dock left Sheerness this week for Bermuda in charge of three tugs. The mammoth structure will be taken direct to Bermuda, 600 tons of coal being stored in the dock for the use of the tugs on their voyage. The dock, which is expected to arrive at Bermuda at the end of July, has cost the Admiralty over £200,000.

DOUBLE BORING MILL

MESSRS. WEBSTER AND BENNETT, COVENTRY, ENGINEERS



DOUBLE BORING MILL.

ONE of the advantages which the smaller boring mills possess over the lathe—an advantage which can hardly be denied by the stoutest advocates of the older machine—is the possibility of making them duplex or even multiplex. Of course, we have double lathes, and double boring machines are very common and economical. The mill, however, lends itself more kindly to this treatment than the lathe, and several excellent types are extant. Probably Webster and Bennett, of Coventry, have given the question of compound vertical tools as much attention as any one in this country. They have recently completed the double boring and turning mill, which is illustrated on this and the next page, to entirely new designs. The machine consists of two tools with one common body, but in all other respects quite independent. Of course, one operator looks after both sides.

The chucks or tables are driven by large spur gearing, which has a pressure ring running in oil to take the down thrust. The spindles are of large diameter, and the bearings are adjustable for wear. The driving cones take wide belts, and the power is still further supplemented by double purchase gearing, thrown in or out of action by moving handles at the front of the machine. The turrets are bored to receive the tools, which are securely clamped in position. The driving mechanism is of steel and hardened. Both turret slides are fitted with indicated swivels for taper boring or turning. A positive stop is fitted to set each turret central with its chuck when boring. All the feed motions, vertical, angular, and horizontal, are automatic, positive, reversible, and self-stopping.

The feeds of the two turrets are in every way independent of each other. The trip motions are simple in their action, and work when the direction of any feed is reversed. They are of the same design as that illustrated in our issue of October 4th last, when a smaller machine of the same kind was described and illustrated by engravings and drawings. The trip dials are marked in eighths of an inch. The rate of feed is changed by the movement of a lever. The turret slides are balanced to allow of easy manipulation. All gears are cut from the solid blank.

The principal dimensions are :—Diameter of chuck, 30in. ; diameter of turret, 12in. ; diameter of turret holes, 2in. ; number of turret holes, 5 ; automatic travel of turret, 16in. ; maximum height, table to turret, 22in. ; height, table to cross slide, 16in. ; number of table speeds, 16 ; number of rates of feed, 6 ; four-speed cone, 14in. to 8 by 3½in. belt ; size of fast and loose pulleys, 14in. diameter by 3½in. belt ; revolutions per minute, 180 and 300 ; floor space occupied, 10ft. by 5ft. 3in. ; approximate weight, 4½ tons.

PROGRESS OF THE SIMPLON TUNNEL.

WE drew attention to the fact that at the close of last year the progress of this great engineering work was seriously impeded by the sudden influx of enormous quantities of water. The invasion was fortunately restricted nearly altogether to the southern or Italian end of the tunnel, where no less than a dozen outlets or sources contributed to the supply. It is satisfactory to note that up to the present time the number has not increased. The formidable pressure exercised by the water leads to the conclusion that the majority of the sources had their origin in a large basin or subterranean reservoir existing among the cavities and fissures of the gneiss and calcareous rock formations. It is not difficult to understand that the piercing of a tunnel, tapping at numerous points a basin of this description, must be attended by a very powerful disturbance of its previous equilibrium and stability. The flow would continue to increase in proportion to the number of openings successively provided. When this number remained constant the flow would attain its maximum, and remain also fairly constant until the sources of supply commenced to dry up. This represents the actual state of the case. Since the time when the twelve outlets were in full play the quantity of water has flowed at nearly a uniform rate of 200 gallons per second. As a matter of fact, the sources are diminishing, and will no doubt continue to do so until the reservoir is exhausted. The quantity of water at present flowing, although considerable, does not retard the progress of the work.

Our latest advices are to the effect that, out of a total length of 21,700 yards, 12,460 have been pierced, the percentage of the completed and uncompleted distances being as 57 to 43. The date fixed for the finishing of the work is May 14th, 1904, or about two years hence. To accomplish this task, thirteen lineal yards must be pierced and excavated per diem for the two headings. Provided, as is expected, that no other difficulties present themselves, that the existing ones upon the south side will be speedily overcome, and that the character of the rock will be such as the geological section represents, the work is quite possible of fulfilment. At the same time, the estimated daily advance of the headings exceeds by 2½ yards that accomplished at the Arlberg tunnel. It is admitted by the Jura-Simplon Company that the present length completed is 500 yards less than that prescribed by the official stipulations. This difference, in an engineering work of such magnitude, and constructed under such difficulties, may be fairly disregarded.

MANCHESTER ASSOCIATION OF ENGINEERS.

THE first of the summer excursions in connection with the Manchester Association of Engineers took place on Thursday last, when the members, to the number of about 120, visited the extensive works of John Brown and Co., Limited, Sheffield, where they were received by Mr. Ellis, jun., and Mr. E. Middleton, secretary of the company. Unfortunately, at the time of the visit, the works were only very partially in operation, the steel section and armour-plate shops being practically idle, waiting for Admiralty orders. An opportunity was, however, afforded for an unrestricted tour through all departments of the works, which provided much matter of interest to the members. Amongst specialities which attracted attention was the Ellis and Eaves patent system of induced draught, a large installation of which—for thirty boilers—has been put down in the works. The system is already well known, and it is not necessary to more than briefly indicate some of the main features of the plant erected by the firm on the most approved principles. In this arrangement the gases on leaving the smoke-box pass upwards through the air-heating boxes, and thence direct to the fan by as short a route as possible, so that there is a minimum of loss due to tortuous passages ; indeed, in actual practice it is found that the vacuum in the smoke-box is the same as at the fan inlet. The air is led from the heating-boxes down passages on both sides of the smoke-boxes, and enters the fire through regulating valves on the furnace mouthpiece or front. As now arranged there is nothing about the system that entails any special structural difficulties beyond what would be involved in any other efficient system of mechanical draught. The members had also an opportunity of seeing the forging and rolling of railway tires, and the rolling of boiler flues from the thick slabs, together with the subsequent welding by an ingeniously arranged portable gas furnace in conjunction with a powerful steam hammer. A number of special tools recently added to the plant also attracted attention. On the conclusion of the visit, Mr. E. G. Constantine, the president, said he

was sure they would all join in passing a hearty vote of thanks to the firm for allowing them to visit the works, coupled with the name of Mr. Ellis, jun., and the members of the staff who had shown them through the various departments. Mr. Henry Webb, in cordially seconding the motion, said they had heard a good deal about automatic tools of late, and the subject was often discussed as if there was only one place in the world where these could be made, and that was America. He had nothing to say against America. In England we had ungrudgingly thrown open our shops to our American friends, who had thus been able to see all that was being done in this country, and, by opening on green soil, they had perhaps gone one better. He thought, however, they had no longer any need in the States, with their high protective duties, to taunt us on the matter, or that we did not change our tools often enough. There was no country on the face of the earth that could beat Sheffield in the matter of automatic tools and apparatus, or that could make as good steel for speed cuts, and, in fact, for all purposes, as was being produced there. Further, the finest armour plates and forgings for propeller shafts, &c., were being produced in that important industrial centre, which had always been to the front with its special manufactures. Mr. Ellis, jun., in responding to the vote of thanks, said: Reference having been made to the introduction of automatic machinery, he might mention that they were handling steel ingots to the extent of 20,000 tons annually, at an average cost for labour of 4s. per ton, and this was the result of automatic labour-saving appliances. Their constant endeavour in the equipment of the works was to keep abreast of the times. Last year the shareholders allowed them to spend £100,000 in further extensions and new developments, and it would perhaps not be going outside the mark to say that £50,000 scarcely represented what it was necessary to spend per annum to keep their works to the forefront with the progress of engineering science.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

RADIATION OF SURFACES.

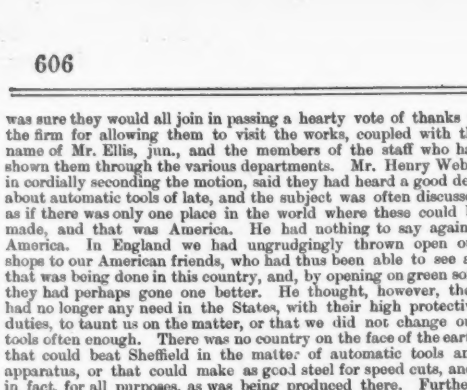
SIR,—In almost all text-books on heat will be found a description of the experiment known as Leslie's Cube, an outline of which is as follows:—If a cube of metal have three of its faces painted with different substances, one of which is lamp-black, and the other face be of polished metal, it will be found that if the cube be filled with boiling water, a lump of wax will melt at a much greater distance from the lamp-black surface than from the silver surface. From this it is deduced that a bright surface does not radiate as much heat as a black. Conversly it is found that a bright surface does not absorb as much heat as a dull one—a fact which accounts for the coolness of the nickel-plated parts of a bicycle standing in the sun as compared with the black parts of the frame.

Now, many people seem to have jumped to the conclusion from the above experiments that a black surface will *disperse* more heat than a bright one, some even appearing to think that the heat-dispersing power of a surface is the same as its radiating power, or, in other words, that a bright silver surface will not disperse one-twentieth part of the heat which a black surface will get rid of. This is entirely a fallacy. As a matter of fact, I have never observed a greater difference than 20 per cent., and in many cases I have failed to detect any difference at all.

The following direct experiments may be of interest:—

The cooling of water.—The apparatus used for this experiment was as follows:—A wedge-shaped tin-plate vessel, so placed that its base is an isosceles triangle having two sides 9in. long, and the base 6in., and having a height of 9in., was filled with hot water, and the rate of cooling noted (1) when smooth and bright, (2) when smooth and black, (3) when two of its sides were covered with gills or fins having a collective cooling surface—counting one side of the gill only—of about 85 per cent. of the surface of the vessel, (*a*) bright, and (*b*) black. All these experiments being repeated with (I.) still air, (II.) a gentle breeze directed at the point of the wedge so as to strike two 9 × 9 faces, (III.) a fresh breeze imilarly arranged.

The blacking material was benzoline and lamp-black, put on cold



Fall in Temperature of 8 lbs. of water in a vessel having 2·75 Sq. feet of cooling surface Atmosphere 60° F

and allowed to dry. At the end of the experiment the vessel was painted with a mixture of lamp-black, turpentine, and a little linseed oil—the paint which would have to be used in practice to ensure its not coming off—to find out whether the varnish formed by the oil would retard the cooling. No noticeable difference could be detected. Lastly, the vessel was painted with aluminium paint to see if the particles of aluminium would help to disperse the heat, the paint being blackened with a little lamp-black. No improvement could be detected.

The table gives the dispersion in British thermal units per square foot per hour. In every case these results are deduced from noting the time by stop-watch which the water in the vessel took to cool from 200 deg. Fah. to 190 deg. Fah. The vessel weighed 1 lb. empty, and held 8 lb. of water. Each result is the average of three experiments. The results did not differ sufficiently to be worth giving in detail. The actual surface of the vessel was as follows:—The bottom was on a board, and the top covered with a sheet of asbestos, and these are neglected. The cooling surface of the plain vessel would therefore be two 9 × 9 sides plus one 6 × 9 side, or 1·5 square feet.

In the gill experiment forty strips of 36 gauge tin-plate—having a thickness of 76 ten-thousandths of an inch—were turned up ¼in. along one edge, and this ¼in. part soldered, horizontally, to the 9in. side of the vessel, so that these two sides were covered with ½in. deep gills spaced a little over ½in. apart. Of course, such a gill ½in. deep and 9in. long has a cooling surface of 9 square inches—considering both sides—but for the purposes of this experiment only one side was considered, forty such gills being considered to have a cooling surface of 1·25 square feet.

The table gives the cooling effect of the plain vessel. The total vessel, including the surface and the gills, and lastly the gills only; this last being obtained by calculating the cooling effect from results (1) and (2) for the plain surface and crediting the gills with the balance.

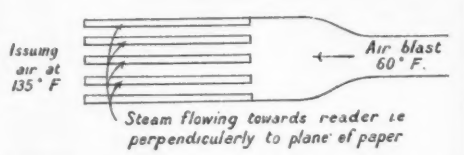
It will be noted that for still air and a plain surface blacking is of some good, but that in a breeze there is little difference. As might be expected, gills are much more effective in a draught than still air.

Air condensers.—In addition to the above experiments on the cooling of water, a few were tried on the actual condensation of steam.

(I.) Some two years ago I had a surface condenser made by soldering together two sheets of tin-plate, between which the steam was passed. Before entering the condenser the steam pipe passed through a short length of pipe under water, the drainage from which was not allowed to enter the condenser, in order to ensure the steam in the condenser not being superheated.

This arrangement was tried when passing 40 lb. of steam per hour:—(*a*) In still air with a bright surface; (*b*) in still air with a black surface; (*c*) in a gentle breeze directed at one side only with a bright surface. Probably the breeze in this case was very inefficient. The total surface was about 25 square feet, and the best result obtained was 10 lb. of water condensed per hour.

Within the last few days I have tried another condenser. THE ENGINEER has often recommended the use of a boiler made of flat sheets of metal joined round the edges, with water between the sheets, and the flame playing up between the plates. A short calculation will show that this gives an enormous heating surface



in a small space. A little further consideration will also show that there are very great structural difficulties in the way of making such a boiler, which probably accounts for the absence of such boilers from the market to-day, though they have been used in the past. This form of construction, however, lends itself more to air condensers, and it was on these lines that the present condenser was made.

Eight very much flattened tubes, ¼in. by 12in. inside, were passed through long slots cut in two sheets of metal and soldered in place. The ends were covered over and coupled up to the exhaust from the engine, and open to the air respectively. A drain pipe was arranged at one end. The surfaces are painted black, and the total cooling surface was about 27 square feet.

(II.) This experiment was conducted with a very gentle breeze playing on the edges of the elements, so that the air passed between the plates at right angles to the flow of the steam. Measurements were taken: (*a*) When 25 lb. steam per hour was passing through the condenser; (*b*) when 60 lb. per hour was passing; (*c*) when 60 lb. per hour was passing and the steam pipe just before the condenser was kept cool with water; condensation separately drained, in order to make sure there was no superheat. In every case the condensation was under 10 lb. per hour, the experiments lasting fifteen minutes each.

(III.) In this experiment the strength of the blast was increased to a fresh breeze of from 15 to 20 miles per hour. Experiment lasted one hour, and 18 lb. of steam was condensed.

(IV.) The edges of the flattened tubes of the condenser were in this case all covered over by a large inverted funnel soldered to the outer ones, as seen in section, Fig. 1, and a fan blast from a No. 00 Sturtevant fan turned into the opening. The amount of steam passing through the condenser was 60 lb. per hour, and the total condensation was 22½ lb. in one hour. The temperature of the atmosphere in all the above experiments was 60 deg. Fah., and in this experiment—No. IV.—the temperature of the air on leaving the condenser was 135 deg. Fah.

TABLE.—*Loss of Heat from Surface in B.T.U. per Hour.*

	Still air	Gentle breeze.	Fresh breeze.
Plain, bright	560	1230	1795
,, black	675	1230	1880
Surface with gills equal 85 per cent. of plain surface, bright	424	1043	1600
Ditto, black	488	1250	1925
Gills only, bright	258	823	1385
Ditto, black	266	1240	2050

In experiment No. III., at the conclusion of the trial the temperature of the steam on leaving and on entering the condenser, both with and without a jet of water playing on the exhaust pipe, was taken and found in all cases to be between 210 deg. Fah. and 205 deg. Fah.

Conclusions.—It would appear from the condensation experiments that in a practical condenser the maximum condensation which can be expected is about ½ lb. per square foot per hour.

It will be noted that the condensation experiments giving as a maximum in experiment No. III. ·65 lb. per square foot per hour, or, roughly, 630 units per hour, does not agree with the dispersion given in the cooling experiments, under similar conditions, which was found to be 1900 units. Presumably, the difference is accounted for by the fact that in the cooling experiment any radiation from the surfaces would escape, whilst in the condenser experiment radiation from one plate would impinge on and be absorbed by another, so that the total cooling effect would be that due to conduction. This conclusion is borne out by a comparison of the cooling effect of the smooth vessel in still air with the condensation experiment No. I. with a flat-plate condenser. In this case the results are fairly nearly the same. On the whole, for moderate speeds of air the condensation experiments are more likely to be trustworthy, as it is impossible in practice to avoid so arranging the surfaces that radiation from one will not strike another.

Turning now to "B.E.'s" letter in your issue of May 30th.—A leading authority on internal combustion engines has said that about 50 per cent. of the heat developed goes off in the jacket water. Further, these engines take, roughly, 1 lb. of fuel per brake horse-power, and each pound of fuel will give about 18,000 B.T. units, so that 9000 units have to be dispersed from the radiator per hour for each brake horse-power.

As to the cooling effect throughout the whole scale from 200 to 110, I can only refer him to the curve given. I am afraid a formula is a little beyond me, but I should think it would take the form of $\frac{a-a^1}{t-t^1} = ian\ C\ a^n$ where t is the time, a the difference in temperature, between the water and atmosphere, and C and n are constants.

The method of measuring the strength of the wind.—This was done by coupling an ordinary air-blast gauge to a small 45 deg. funnel, 2½in. across the mouth, by a rubber tube, and then noting the reading of the gauge when this funnel was held normal to the blast at the point at which the strength was required, and comparing the results with similar readings obtained in the open air on a windy day. Of course, this is a crude method, but gives some guide.

Camborne, June 9th. J. S. V. BICKFORD.

CHIMNEY ERECTION.

SIR,—We notice in THE ENGINEER of April 18th, page 391, a letter from a contractor describing the manner in which five steel chimneys have been erected for the British Westinghouse Company, and asking if the readers of your paper know of any stacks that have been erected in a similar fashion. We may inform you that most of the stacks on the Rand, which vary in height up to 160ft., and in diameter up to 10ft., have been erected exactly as described, and it is quite unusual for a stack to be erected in any other way.

Johannesburg, May 23rd. J. H.

LAUNCHES AND TRIAL TRIPS.

FULWELL, three-deck steamer; built by, Joseph L. Thompson and Son, Limited; to the order of, the Tyzack and Pranfoot Steam Shipping Company, Limited, Sunderland; dimensions, 365ft., 50ft. 6in., by 25ft. 11in.; constructed by, John Dickinson and Sons, Limited, for the Atlantic and Eastern trades; launch, May 31st.

TUSCANY, steamship; built by, Sir W. G. Armstrong, Whitworth and Co.; to the order of, Messrs. Lane and Macandrew, London; dimensions, 363ft., 47ft., by 29ft.; to carry, petroleum in bulk; engines, triple-expansion, 25in., 42in., 65in., by 45in., pressure 180 lb.; constructed by, Wallsend Slipway and Engineering Company, Limited; boilers constructed for oil fuel as well as coal; launch, 4th inst.

GRAMPUS, suction pump dredger; built by, Wm. Simons and Co., Limited, Renfrew; to the order of, Sir Walter Peace, Agent-General for Natal; dimensions, 218ft., 36ft. 6in., by 16ft 7in.; to carry, 1300 tons of dredgings; engines, two sets triple-expansion, 1450 horse-power; pumps are capable of raising 3000 tons of sand per hour from a depth of 34ft. under water level; launch June 4th.

DRUMBAIN, steel screw steamer; built by, Wm. Gray and Co., Limited, West Hartlepool; to the order of, Messrs. W. Christie and Co., London and Ardrossan; dimensions, 312ft., 43ft., by 22ft. 3in.; engines, triple-expansion, 22in., 35in., 59in., by 39in., pressure 180 lb.; constructed by, Central Marine Engine Works of builders; speed averaged 10½ knots; trial trip, June 4th.

AUGUST BELMONT, steam collier; built by, C. S. Swan and Hunter; to the order of, the Louisville and Nashville Railroad Company; to carry, deadweight, 6800 tons; engines, triple-expansion, of 2000 indicated horse-power; constructed by, Wallsend Slipway and Engineering Company; speed 10—11 knots; tria trip, June 5th.

CROXDALE, steel screw steamer; built by, the Tyne Iron Shipbuilding Company, Limited; to the order of, Messrs. G. H. Elder and Co., Newcastle; dimensions, 325ft., 45ft., 25ft. 3in. deep; engines, triple-expansion, 24in., 40in, 64in., by 42in., pressure 180 lb.; constructed by, North-Eastern Marine Engineering Company, Limited; launch, June 7th.

THISTLEROY, single-deck type steamer; built by, Irvine's Shipbuilding and Dry Docks Company, Limited; to the order of, the Albion Line, Limited; dimensions, 360ft., 47ft. 9in., by 30ft. 2½in.; to carry, cargo; engines, triple-expansion, 25in., 41in., 67in., by 45in., pressure 165 lb.; constructed by, Richardsons, Westgarth and Co., Limited; mean speed of 11 knots attained; trial trip, June 7th.

OMBRA, twin-screw steam yacht; built by, David and Wm. Henderson and Co., Limited, Partick; to the order of, Baron W. von Schroeder; dimensions, 156ft., 20ft., by 13ft. 6in.; engines, two sets triple-expansion, 10in., 16in., 26½in., by 18in., pressure 180 lb.; launch, June 8th.

LUZON, steel screw steamer; built by, Robt. Stephenson and Co., Limited, Hebburn-on-Tyne; to the order of, Società Anonima Ungherdi Armamento Marithmo Oriente, of Fiume; dimensions, 340ft., 47ft., by 29ft. 10in.; engines, triple-expansion, pressure 165 lb.; constructed by Richardsons, Westgarth and Co., Limited; launch, June 9th.

CHOY SANG, steel screw steamer; built by, Wigham Richardson and Co., Limited; to the order of, Indo-China Steam Navigation Company, Limited; dimensions, 390ft. by 42ft.; to carry, passengers and cargo; engines, triple-expansion; constructed by, builders; launch, June 9th.

MANCHESTER INVENTOR, cargo steamer; built by, Northumberland Shipbuilding Company, Limited; to the order of, The Manchester Liners; dimensions, 373ft., 48ft., by 30ft. 10in.; to carry, 7000 tons deadweight; engines, triple-expansion, 25in., 41in., and 69in., by 48in., pressure 180 lb.; constructed by, Richardsons, Westgarth and Co., Limited; a speed of 11 knots was easily obtained; trial trip, June 14th.

ROYAL METEOROLOGICAL SOCIETY.—The second afternoon meeting of the present session was held on Wednesday, the 18th inst., at the Society's Rooms, 70, Victoria-street, Westminster, Mr. R. Inwards, F.R.A.S., Vice-president, in the chair. Mr. F. C. Bayard read a paper on "English Climatology, 1891-1900," which is a discussion of the climatological data printed in the "Meteorological Record." In 1874 the Royal Meteorlogical Society commenced the organisation of a series of stations at which the observations are made twice a day on a uniform plan, so that the results may be strictly comparable with each other. In addition to these, the Society in 1880 organised another class of stations, termed climatological, at which the observations are made once a day, viz., at 9 a.m. Mr. Bayard on a former occasion worked up the results from these climatological stations for the ten years 1881-1890, and in the present paper he gives the averages from sixty-nine stations for the ten years 1891-1900. The elements dealt with are temperature, relative humidity, amount of cloud, rainfall, and rainy days, and the results are a valuable contribution to the climatology of the British Isles. A paper by Mr. W. L. Dallas, on "Earth Temperature observations recorded in Upper India," was also read, in which the author discussed the observations made on the temperature of the soil at three stations, viz., Lahore, the capital of the Punjab; Dehra Dun, in the north-west of the North-Western Provinces; and Jaipur, the capital of the native State of that name. The observations, which were made at depths varying from 4in. to 45½ft. below the surface, extended from 1884 to 1899.

MOVING A LARGE BRIDGE.—A railway bridge at Pittsburg, U.S.A., has recently been shifted sideways to make room for the construction of a new bridge on the same site. The bridge carries a double line of railway, and has three through lattice girders to each span, the length of span being 165ft. The old masonry piers were rebuilt under the bridge last summer, and timber supports forming extensions of the piers were built on the down-stream side to carry the old bridge during the erection of the new bridge. These timber piers have solid decks of timbers 12in. square. The old spans were jacked up, and under each end of each span were laid seven lines of 85 lb. flange rails, extending along the masonry and timber piers. Under each end of each span were also seven lines of similar rails, with the heads down, and between the two sets of rails were 2½in. steel rollers 4½ft. long, sixty-six rollers under each end of each span. A set of four-sheave blocks was attached to each end of each span, and other blocks attached to the down-stream ends of the timber piers. The leads of the tackle were carried to a 50 horse-power winding engine at one end of the bridge, a 30 horse-power winding engine at the other end, and a 25 horse-power winding engine mounted on top of the bridge, over the third pier. The rails were not cut, but the five spans were moved as one structure, the three girders being lashed together by wire cable at the attachments of the hauling ropes. The bridge was first moved 23ft. 4in., parallel to its old position. The east end was then fixed in position, and the west end moved 20ft. more, bringing the bridge on a skew in line with the temporary approaches. The actual moving was done in twenty-one minutes, but the total time occupied in the work was about two hours. The new bridge will be a double-deck structure with two lines of rails on each deck.

RAILWAY MATTERS.

WE understand that Mr. Dean retired from the service of the Great Western Railway Company on the 31st ult., and that Mr. G. J. Churchward has been appointed his successor.

THE Midland Great Western Railway Company has decided to provide a station on its railway at Ashtown to accommodate passenger traffic to and from the new Phœnix Park Racecourse.

THE proposed Central Railway in German East Africa, running from Dar-es-Salaam—Mrogoro—Kilimatinde—Tabora—Ujiji, is not yet begun, as the capital has not been raised, and opinions are divided in Germany as to its usefulness.

THE Light Railway Commissioners have granted an application for powers to construct a light railway from Southend to Bradwell-on-Sea, and to Colchester. The expenditure authorised by the Commissioners for the construction and equipment of the proposed line has been fixed at £500,000.

TRAMWAYS operated by compressed air have been running in La Rochelle since August last, and give satisfaction. The speed attained is good, but the cars are not run at sufficiently close intervals to be popular. An improvement in the service and the purchase of more rolling stock are contemplated.

A COMMITTEE of the House of Lords under Lord Brougham on Tuesday passed the Lancashire and Yorkshire Railway (Steam Vessels) Bill, by which the company seeks power to acquire the Drogheda Steam Packet Company and to provide steamers to ply between Liverpool and Fleetwood and Drogheda.

IT is proposed that the Midland Railway Company should revive a scheme, which originated as far back as 1871, for making a line from Grindleford to Hassop. A conference, for the purpose of considering various proposals, was held recently at Bakewell, all the various public bodies interested in the district being represented.

THE Administration of the Prussian railways has just ordered two locomotives of a special type of construction. By means of these locomotives attempts are to be made to increase the speed of the express trains on such sections of the lines as are of heavier build to 130 kiloms. per hour, as compared with 90 kiloms., which is the highest rate of speed obtained on them at present.

AT last week's meeting of the London County Council it was unanimously decided to purchase under the terms of the Tramways Act, 1870, the following lines:—(1) The Woolwich and South-East London Tramways—the whole of the undertaking; (2) the lines authorised by the South London Tramways Company Act of 1881; (3) The London, Deptford, and Greenwich Tramways—the major part of the company's system.

THE London and South-Western Railway Company's new line to Amesbury, on Salisbury Plain, commences by a junction with the Basingstoke and Salisbury line about half-way between Grateley and Porton Stations, and is nearly five miles long. The embankments vary from about 10ft. to 35ft. in height, and the cuttings from 8ft. to 38ft. in depth. The curves vary from one-quarter to two and three-quarter miles radius, and the gradients from 1 in 55 to 1 in 100.

A TANDEM compound decapod has been built at the Baldwin Works for the Atchison, Topeka, and Santa Fé Railroad, and is the heaviest locomotive in the world. It weighs 119½ tons, of which all but 13½ tons is on the drivers. The heating surface is abnormal, being 5390 square feet, and the grate area is 58½ square feet. A couple of small cranes form part of the permanent outfit of the engine, and are for removing the high-pressure piston for inspection. The cylinders are 19in. and 32in. diameter by 32in. stroke.

WE understand that the following changes have been made on the staff in the traffic department of the Great Northern Railway:—General superintendent, Mr. J. Proud; superintendent of the running department, Mr. W. Hills; manager, Mr. G. Shaw; chief passenger agent, Mr. G. Mason; divisional superintendents, Mr. J. Rayner, Mr. J. Webster, and Mr. P. C. Walker; assistant divisional superintendents, Mr. R. Mellson, Mr. H. A. Beavis, and Mr. G. Bolt; district managers, Mr. L. Brightman, Mr. J. Hardy, Mr. J. W. Moore, Mr. G. J. Gifford, Mr. Bryant, and Mr. J. W. Morton.

IT is reported that the Great Central Railway Company is about to materially improve its train connection with the North-Eastern system generally. From July 1st an entirely new through train service will be brought into operation as between Newcastle-on-Tyne and Bournemouth—London and South-Western—*vid* York, Great Central and Banbury branch. A through breakfast car train will leave Newcastle-on-Tyne each week-day at 7.30 a.m. for Bournemouth, travelling *vid* Sunderland and Stockton, and leaving York at 9.25 a.m. *vid* Sheffield, Leicester, and Banbury. A new train will similarly leave Bournemouth.

THE Association of Railway Locomotive Engineers of Great Britain and Ireland had a most successful summer meeting at Lyndhurst on Friday, the 13th inst. On the previous evening the Association gave a complimentary dinner to Mr. William Dean, the locomotive engineer of the Great Western Railway, and Mr. Clayton, the carriage and wagon superintendent of the Midland Railway, on their retirement from their official positions. The whole of the arrangements were carried out by Mr. Harry S. Wainwright, the locomotive engineer of the South-Eastern and Chatham Railway, who is the honorary secretary.

THE City and Surrey Electric Railway Company, which has already obtained powers from Parliament, has acquired a City terminus in King William-street, and a working agreement has been entered into with the South London Company for the joint use of its tunnel under the Thames. Starting from King William-street, the route proposed is parallel to that of the existing South London line to a point a little south of the Borough Station, then branching westward to Kennington, Brixton, Balham, Norbury, Thornton Heath, and Croydon to Wallingham. One branch then proceeds east to Westerham, and the other west to Redhill and Reigate.

THE important amalgamation of the three British railway companies in the consular district of Pernambuco and the leasing by the Federal Government of the south of Pernambuco railway, which is an extension of the old Recife and Sao Francisco railway, has placed the management of these four systems in one hand, that of the Great Western of Brazil Railway Company. The company is now constructing the connecting link between Independencia in Parahyba and Nova Cruz, the present terminus of the Natal—Rio Grande do Norte—railway, and it is proposed to build a branch line in the State of Parahyba from the trunk at Itabaina to a town named Campina Grande.

LAST Monday the Bingley District Council approved a scheme prepared by Mr. Quin, electrical engineer, Blackpool, for a continuous tramway route from Bradford to Keighley. It was also decided that the Council proceed with the scheme for the construction of the new road. Mr. Quin, on behalf of a syndicate, agrees to construct and equip the line of tramways and to take the necessary power for running the line from the Council. The company would pay the Council £500 a year for thirty years, and also the cost of a Provisional Order. The company agreed to contribute £2000 towards the cost of making the new road from Main-street to Keighley-road—an improvement estimated to cost £13,240.

NOTES AND MEMORANDA.

THE scheme for holding a British and colonial exhibition at Capetown for a period of four months from November, 1903, to February, 1904, is making progress.

THE cost per ton of battleships built for the United States navy has gradually diminished. For instance, the Oregon, built in 1890, cost £130, while the contract price for the last five vessels has worked out at about £80 per ton. The actual cost would be rather more than this.

IT is not often that a frozen compass causes the loss of a vessel. Yet the fact of the two spirit compasses of the steam fishing vessel Jamesia becoming frozen during a heavy snowstorm, says the *Syren*, led to the stranding and loss of that vessel off the Iceland coast on March 24th last.

THE Executive Council of the South Wales Miners' Federation, meeting recently at Cardiff, resolved to convene a conference of colliery delegates at Cardiff on the 30th of this month, to decide whether notices shall be given on July 1st to terminate the sliding scale agreement at the end of the year.

THE monthly report of the Amalgamated Society of Engineers asks the branches to nominate gentlemen as parliamentary candidates, it having been decided to run five candidates at the general election. When the five are selected the Executive Council will endeavour to find constituencies suitable to contest.

THE U.S.A. Bureau of Navigation reports 115 vessels of 79,753 gross tons built in the United States and officially numbered during the month of April, 1902. In the month of May the number of vessels built and officially numbered was 126 and their tonnage 34,139. Fourteen of these vessels, aggregating 22,899—or about 67 per cent. of the whole—were from the yards of the Great Lakes.

A CURIOUS effect produced by lightning is described in *Nature* by Dr. Enfield, writing from Jefferson, Iowa, U.S. A house which he visited was struck by lightning, so that much damage was done. After the occurrence a pile of dinner plates, twelve in number, was found to have every other plate broken. It would seem as if the plates constituted a condenser under the intensely electrified condition of the atmosphere.

A COMPOSITION for welding steel has just been patented in America. He employs iron chips, 85 lb.; boracic acid, 15 lb.; gelatine, 6 oz.; water, one and one-fourth quarts. The gelatine is dissolved in the water by heating and added to the chips and thoroughly mixed. Then the acid is added and mixed thoroughly. While borax and other ingredients have often been used in these compositions, boracic acid has never been employed.

THE *Bulletin* of the French Physical Society, No. 182, contains a note on a new "electric valve" for transforming reciprocating currents into direct currents, due to M. Nodon. This "valve" is based on the property, discovered by Buff in 1857, that an aluminium electrode plunged in an electrolyte offers a great resistance to the passage of a current in which it is the anode. The efficiency of M. Nodon's apparatus, as measured by a watt meter, reaches 75 to 80 per cent.

H.M. CONSUL-GENERAL at Callao, in his recent report to the Foreign-office, states that the annual production of alcohol from sugar-cane in Peru is estimated at over 2,000,000 gallons, of which 600,000 gallons are exported to Bolivia, but if other outlets could be secured there would be no difficulty in increasing the production largely. Producers look forward to the use of alcohol in various branches of industry as the only means of developing their business. There is to be an International Exhibition of the Industrial Appliances for Alcohol at Lima next November.

BOTH Italy and the United States have decided to build more submarine boats. The Italian Government have sanctioned the sum of 800,000 lire for an under-water vessel. There are already two submarines in the Italian navy—the Audace and the Delfino. The latter is a small craft, 78ft. in length, and is driven by electricity both on the surface and when submerged. The Naval Committee of the United States Senate has amended the Appropriation Bill, and has provided for the purchase of five further submarines of the latest Holland type, and for investigation into other types.

AN oxy-acetylene blow-pipe is described by M. Fouché in the *Bulletin* of the French Physical Society. The flame is formed by the combustion of a mixture of one part of acetylene to 1·8 of oxygen, and in order that the explosion may not travel back into the blow-pipe, a jet velocity is required, due to the pressure of a water column 4 metres in height. The flame melts most metals readily; it will solder iron and steel, and even silica and lime are melted by it. With a reduction of the proportion of oxygen, the flame becomes luminous, and on falling on lime the free carbon goes to form carbide of lime.

THE manufacture of oil-cake from sunflower seeds, to which we have previously called the attention of our readers, is making progress as an industry in Russia. The British Vice-Consul at Novorossisk states that the sale of the oil-cake produced, in itself more than covers all the working expenditure of the mills. The stalks of the sunflower plant are used as fuel for driving the machinery, and the ash that remains gives from 25 to 30 per cent. of potash. Briefly speaking, it would appear that the sunflower seed when properly crushed gives 23 per cent. oil, 40 per cent. oil-cake, and 37 per cent. stalk.

AN association of manufacturers at home to start a trading company in Turkey, with capable Englishmen to live in Constantinople and manage it, might be worth considering, says the British Consul at that port. Once fairly started on business lines, such an enterprise ought, it is said, to secure the cream of the trade throughout the country. It would command the confidence of manufacturers at home, as well as of native buyers; and would naturally have the support of all British Consulates, which at present have too often to fight the doubtful battles of native merchants who claim protection for British goods.

ACCORDING to the Home-office report for 1900 on the mines and quarries of the world, prepared by Professor C. le Neve Foster, although Great Britain has had for a second time to give to the United States the first place in the production of coal, the British Empire, as a whole, is still the largest producer of solid mineral fuel, yielding nearly one-third of the world's output. The gold output of the British Empire is also the largest, and will probably increase. The United States, however, comes first in the production of the ores of copper, iron, and lead. The German Empire, with 153,350 tons, is the largest zinc producer, and Russia, with 9,827,822 tons, is the largest producer of petroleum.

A NEW law for the protection of industrial property, including patents, and trade marks, in Spain has recently been passed and came into operation on the 7th inst. J. E. Evans-Jackson and Co. inform us that the working conditions of patents have been greatly modified, and a period for compulsory working has been extended to three years. In addition the time for payment of taxes has been extended under a fine, while at the same time it is provided that inventors paying up their taxes in advance obtain discount on the same ranging from 5 to 20 per cent. It is also provided that applicants who have made prior applications in other foreign countries for patents must make application in Spain within twelve months, failing which any patent granted will be limited to five years.

MISCELLANEA.

GREAT industrial distress still prevails in Germany, where the number of the unemployed has again increased, especially in Berlin, Dresden, and Munich.

THE French ironclads Valmy and Jemmapes, and the French cruiser Dupuy-de-Lome, are to engage this month in some combined operations with submarines off Cherbourg.

TWO 80-ton guns, forming the armament of the pier turret at Dover, are to be removed as obsolete, and will probably be destroyed locally, owing to the heavy cost of transport.

SINCE July 1st last year the vessels entering the port of Liverpool have increased by 566,000 tons, as compared with the previous year, and the rates and dues for the same period by about £30,000.

MR. EDISON has sent a party into the Canadian "Nickel Belt" to make experiments with an electrical dipping needle which he has invented, which is said to indicate accurately the presence of ore beneath the surface.

THE death occurred last week of Mr. James Shand, M. Inst. C.E. He was born at Edinburgh in 1823, and was widely known in connection with the manufacture and improvement of fire engines, and especially of the steam fire engine.

AMONG the many valuable drawings destroyed in the recent fire which took place in the mould loft at Chatham Dockyard was that of the Devonshire. The loss, which was estimated at £50,000, is now considered more likely to amount to nearly £75,000.

THE Annagh bog, near Carrick-on-Shannon, county Leitrim, which is several hundred acres in extent, split on Monday night and moved a considerable distance. One house was overwhelmed and other damage was done to property, but there has been no loss of life.

A TELEGRAM from New York states that the new shipbuilding combination has been definitely formed, with a capital of 20,000,000 dols., not including 16,000,000 dols. in bonds. The combination includes eight large concerns, and it is said that it contemplates building the largest dry dock in the world on Staten Island.

IN a telegram received from Asmara the *Tribuna* learns that the Negus Menelik has granted Italy a mining concession for a definite period with regard to the region lying between Lake Tsana, the Guna mountains, and Lake Ashangi. An Italian company has been formed for the purpose of working this concession.

WOLVERHAMPTON has succeeded where others failed, and has now its own municipal cold stores and ice factory. According to *Cold Storage*, neither Walsall nor Rochdale was empowered to sell ice, and in view of the evidence given before the Joint Committee on Municipal Trading, which ought to have been reappointed long before this, it is difficult to understand why Wolverhampton has been granted the privilege.

ANOTHER flying machine inventor named Smuty came near to losing his life last Saturday in Paris. Having taken his apparatus to the middle of the footbridge across the Seine leading from the Boulogne gate of the Bois de Boulogne to St. Cloud side of the river, he stood upon the parapet, and, with the wings which he proposed to move with his arms, he jumped off, expecting to rise in the air. Instead he fell into the river below and was rescued.

THE mining industry, which forms a main branch of the export trade of Peru, has attained a considerable development of late years. There is undoubtedly immense mineral wealth in Peru; but progress is retarded to some extent by the want of capital, cheap means of communication with the coast, and the scarcity of labour. The official returns show that the total number of mining claims registered was 1753 in 1880, 3490 in 1890, and 5178 in 1900.

NEARLY all the nickel used in the United States is obtained from the mines in the Sudbury district, Canada, which produce probably one-half of the nickel used in the world. The other chief sources of nickel are the mines of New Caledonia, in the Pacific Ocean, and of Silesia, Austria. Nickel deposits are being developed satisfactorily near Hangesund, in Norway, and a supposed extensive deposit of nickel has been discovered on the head waters of Tulameen River, British Columbia.

THE india-rubber industry is likely to progress, as, from all accounts, the forests of Peru contain innumerable rubber trees. From July 1st, 1900, to July 30th, 1901, grants amounting in the aggregate to 1,240,000 acres of forest land, said to contain valuable rubber trees, have been made by the Government. These lands lie in the departments of Huanuco and Cuzco. The periods of the grants are either five or ten years. The royalty claimed by the Government is 2s. for every quintal of rubber which is exported.

ACCORDING to information from St. Petersburg, the Russian Ministry of Finance has drafted a Bill permitting the grant of State Loans, free of interest, to Russian shipbuilders to the amount of half the value of any new ship under construction, on condition that only Russian material is used and that the ships are to be of the most modern type, approved of by the Ministry. The Bill, says the Berlin correspondent of the *Standard*, also provides that the Russian Government may pay for half the coal consumed by the ships on voyages between Russian ports, or between a Russian and a foreign port, on condition that only Russian coal is consumed.

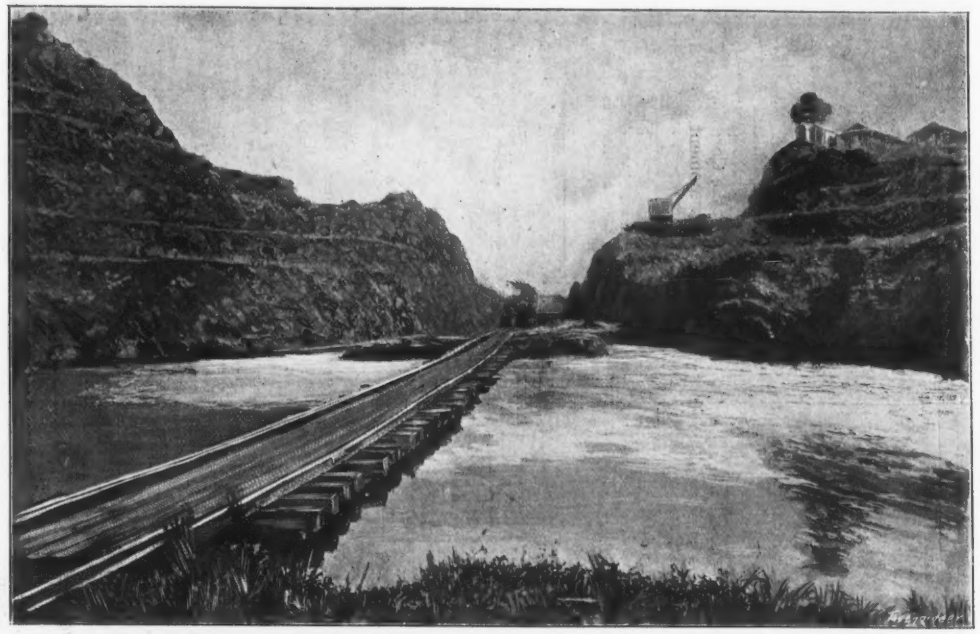
A RICE-CLEANING factory was started in South Formosa in the beginning of 1900, and a small steam mill was used for the first time instead of the native mills. The experiment proved a success, and although the sales at first were slow, owing to the superstitions of the natives, the cleaner quality of the rice and the cheaper price at which it was sold gradually brought it into favour. The demand increasing, a larger mill with an output of 20 tons a day has been erected, and it is intended later to erect a similar one at Takow and at other places as required. The machinery for the mill was purchased in the United States and the United Kingdom.

THE second trunnion bascule bridge in America has now been completed. This is the Clybourne-place bridge over the Chicago River, the first bridge of its type being that over the Milwaukee River at Grand-avenue, Milwaukee, Wis. The Clybourne-place bridge is 128ft. long between trunnions, and gives a clear waterway of 100ft. There are three through trusses, 9ft. deep at the ends—or the middle of the bridge—and 24ft. deep over the trunnions, beyond which the top chord curves with a radius of 26ft. 4in. The operating rack is attached to the curved heel of the truss, and gears with a driving pinion below the street level. The total weight is about 650 tons.

FEW places are better provided with telegraphic communication than Pernambuco, where the cables of two Transatlantic companies are landed, viz., the Western Telegraph Company, Limited, and the South American Cable Company, Limited; the former company works to St. Vincent—Cape Verdi—Madeira, and Lisbon, and the latter connects at Senegal on the West Coast of Africa, having a station at Fernando da Noronha, an island about 300 miles off Pernambuco, which serves excellently well as a signal station for passing vessels. The Western Telegraph Company carries its cable along the coast from Pará to Rio Grande do Sul, and thence to Monte Video, touching at all the principal towns.

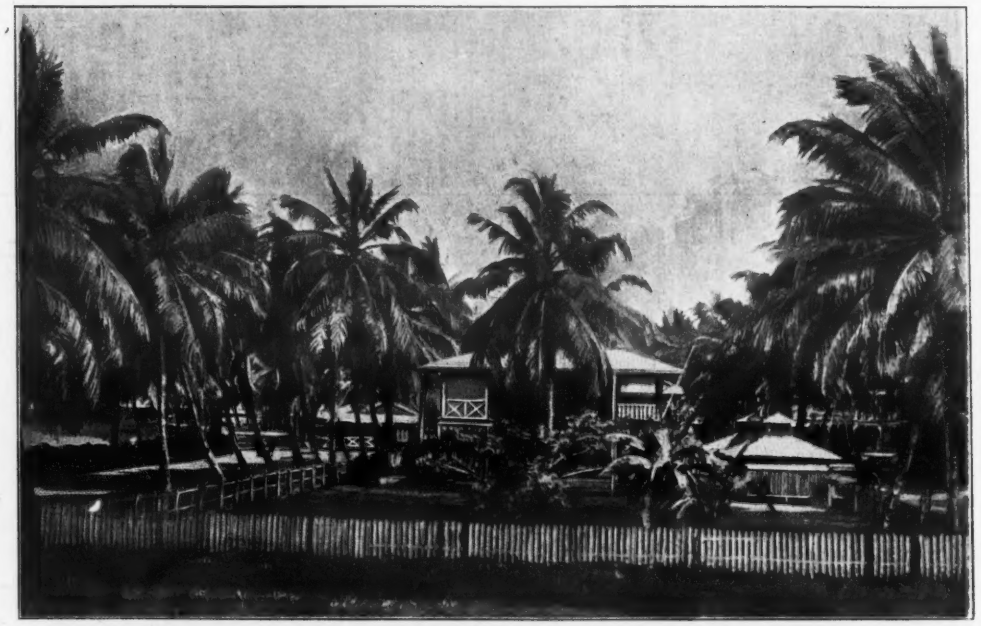
THE PROPOSED INTEROCEANIC CANAL

(For description see page 597)



OBISPO, SITE FOR THE GUARD-GATES

SCENE ON THE UPPER CHAGRES



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ALHAJUELA, UPPER CHAGRES

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☞ *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

J. M. C. (Totnes).—Write to W. Neville and Co., Llanelly, or to Mr. C. D. Phillips, Newport, Monmouth.

J. A. R.—There is no money to be made out of inventions for utilising the waves or the tides for the production of power.

B. S. A. (Dublin).—One of our objects in sending out a Special Commissioner to South Africa is to obtain information of the kind you want. You cannot do better at present than wait, unless, indeed, you have friends at the Cape or in Natal to whom you could go.

WATER METER.—There is no difficulty about starting a jet condenser. Steam is blown through it to expel the air, through a special snifting valve fitted for the purpose. When the clear steam issues from the valve the blow-through cock is shut. In a very short time the steam in the condenser is reconverted into water, and the jet will then start as soon as the injection cock is opened.

W. N. (Preston).—As far as we can gather, the German bounty scheme is based on a scale whereby the Coal Syndicate contributes 1s. 6d. per ton of coal used in the production of exports, the Crude Iron Syndicate 2s. 6d. per ton, and the Unmanufactured Iron Syndicate 3s. per ton. The scheme has not yet been finally settled. The details in regard to the exports will be arranged by an adjustment bureau to be established in Düsseldorf, where Herr Schrodter, secretary of the Verein Deutscher Eisenhuttenleute, will act as one of the managers.

THE HARDIE-THOMPSON WATER-TUBE BOILER.

SIR,—In THE ENGINEER of May 9th, just to hand, I notice an error has been made in the title given to the illustration of a water-tube boiler on page 468. This should have been Hardie-Thompson instead of Hardie water-tube boiler as given. The boiler is known locally under the combined name, and all patents have been taken out with the same title. I regret distance and corresponding delay in making this correction, which is due to my associate in these patents, and trust you will find space for an early insertion of this letter.

3, Bridge-street, Victoria, B.C., GORDON H. HARDIE.
May 27th.

INQUIRIES.

PURE TIN FOIL.

SIR,—I shall be obliged to any reader who will give me the address of an English maker of pure tin foil. I do not care to use the German-made foil.

Westminster, June 17th. H. E. W.

THE ENGINEER.

JUNE 20, 1902.

THE COMMERCIAL SITUATION.

IT has, we think, become desirable—even necessary—that the position of the manufacturers of this country should be carefully considered, with what object will appear before we have done. On all sides we are threatened with loss of markets. Our very means of earning money are being bought from us by such men as Pierpont Morgan. Labour assails the manufacturer on one side; municipal trading attacks him on another. His competitors can import what they please into this country without contributing one farthing to the national expenses to provide for which he is taxed. He is met in every market in the world by a hostile tariff. As the years progress, the conditions under which we live and work and trade shift and change. Those who best understand political economy, ancient and modern, hold that there are no immutable principles on which the science is based. An important school of thinkers is growing up among us who assert with vigour that what was good for the Great Britain of half a century ago is very far from being the best for her now. We have but to study the signs of the times to note the unrest that prevails. Federation, a Zollverein, preferential tariffs, changes in the shipping laws, are talked of, written about, debated in clubs, discussed on Exchanges. A little more, and the country will be fairly aroused. Action will be taken—to what end?

The conclusion of peace has intensified the situation. We have expended some £400,000,000 sterling, and not a little of the best blood of this country and her Colonies, on the acquisition of an enormous territory in South Africa. To what end? Is it to furnish farms for the overflow of our continental rivals? Is it to supply a market for German wares? To us it appears that the moment has arrived when those on whose prosperity the life of this country hangs should speak with no uncertain voice. Cobden and Bright maintained that even if the agricultural interests of this country suffered to the verge of ruin, it was none the less desirable, even essential, that the manufacturer should have cheap food for his men. We need not now consider Cobden's dream of universal Free Trade. It is enough for our purpose to point out that the most advanced school of Free Traders that the world has ever seen, maintained deliberately and of set purpose that the prosperity of the manufacturer was of such importance to the nation, that the sacrifice of the agricultural industry was justified. But the manufacturer is now of far more importance than he ever was before. If exceptional legislation in his favour was once desirable, it is now more desirable than ever. The production and sale of commodities are the life blood of the nation. Arrest the flow of trade and the people die. It is a recognition of this truth that is now inspiring so many able men to regard with unorthodox favour schemes which may lead to the consolidation of the Empire and the improvement of the conditions under which trade and manufactures are now carried on. It is an open secret that manufacturing engineers all over the country are discontented, alarmed, unsatisfied. The report of the Committee on Electrical Legislation now being considered in our columns is but one manifestation of this feeling of unrest. The appointment of a Committee on Shipping Legislation, about which a good deal more will be heard, is another. The promised interview between Mr. Chamberlain and colonial premiers is looked forward to with attention, even anxiety. It is impossible that matters can proceed much longer in the old grooves. However well content we in this country might be to drive along the old road, our commercial rivals will not permit us. The enormous accumulation of capital in a few hands in the United States is a new power in the world, a new influence. We must take count with such matters.

The time has not yet arrived when we can write without uncertainty as to the best course to pursue, the best course to follow. The one thing lacking at the moment is an expression of opinion that shall be conclusive and unmistakeable. We stand this day at the parting of ways. A choice must be made, and the choice proclaimed with no uncertain breath. Either the manufacturers and traders of this country hold that all things are good as they are, or they believe that change is necessary. Why any longer keep silence? Who knows better what is good for the trade of this country than the thousands of able men who live by it? Only let the choice be made with consideration for the present, not out of deference to the past. For the present need the opinions of William the Conqueror and John Bright are about of equal value.

Some one must take action, and the action should be taken by those most immediately interested. The time has come when fetish worship should be abandoned. Every system of trading, every method of raising revenue should be considered on its own merits, and these will be greater or less, not because the systems typified do or do not comply with the ideas of Adam Smith, John Stuart Mill, or any other authority living or dead, but just in so far as they are the best that it is possible to choose under conditions of which the old school of political economists never heard. It forms no part of our purpose at this moment to advocate Free Trade, Fair Trade, Protection, or a Zollverein. That is not our object in writing as we do. Much has been heard lately of a clean slate: let us apply the somewhat clumsy metaphor to existing ideas concerning the way in which trade ought to be carried on. Let us consider, without regard for the sanctity of an authority, what is likely to be of use now. If the needs of the nation could give us a new school of philosophers whose labours resulted in the repeal of the Corn Laws, why should not the situation at this moment, when a great war has ended, develop another body of thinkers, who can do for the country what their forerunners have done? Parliament may take action. Important events in the polity of nations may occur at any moment. There will, we think, be no excuse available and worthy that can be advanced by the manufacturing engineers of this country, if their voices and their influence are not exerted in directing the course of these events in the way most likely to conduce to their own welfare and that of the British nation.

We have said that a clear expression is most desirable. We suggest that our readers should communicate with us, freely, fully. What they please to write will, as a matter of course, be regarded as confidential. Interchange of ideas cannot fail to be of use. Nothing can be lost; much may be gained if those most interested will state clearly what policy they wish to see followed, and why that policy, whatever it may be, appears to each to be the best.

LEGISLATION AND ELECTRICAL ENGINEERING.

IN our issues for May 30th and June 13th will be found the first two of a series of articles based on the report of the Committee of the Institution of Electrical Engineers on Electricity and Legislation. One of the final conclusions of that Committee was that a deputation should wait on Mr. G. Balfour to advocate certain changes in the law affecting electrical enterprise. The nature of the proposed changes will have been gathered by our readers from what we have already written. The interview between the deputation and the President of the

Board of Trade took place, after a postponement, on Wednesday. It brought up again a question of national importance. Broadly speaking, it was a strong protest against the hampering of electrical industries by legal restraints, especially in the hands of local authorities. Mr. Swinburne certainly said in the most definite way that the Institution did not oppose municipal trading, and obviously the Institution could not do so officially, partly because that is not its business, and partly because many of its members are engineers to local authorities. All the same the whole movement is a veiled attack on municipalism, in so far as it affects the electrical industry, whether it was so intended or not.

Electrical distribution, especially for lighting, began on a very small scale; but it was necessary to interfere with roads, which are controlled by local authorities, and this gave the local authorities a chance of getting their tentacles over the industry at the very beginning. Parliament not only gave the local authorities all sorts of powers because they had to do with the roads, but it thought electric lighting might become a very paying industry. No company should be allowed to reap a big reward, so the twenty-one years' purchase clause was put in. If electric lighting went badly, the pioneer companies must pay the loss; if well, the local authorities were to have the benefit. Result—want of capital, inanition, and dropping behind. In 1888 the time was lengthened to forty-two years. Now, the question of roads is a mere accident. If electrical energy could be conveniently distributed by ether waves, no Acts would be needed, and no purchase clause would have been considered. The street question has been an excuse for plundering the industry in favour of local authorities.

But we no longer distribute over small local areas. Engineers deal with large towns fed by outside stations; electric tramways are inter-urban, and connect one big town with the others in other counties; power schemes deal with several counties at a time. Yet the law is still parochial, and the whole industry depends on the goodwill of little local authorities. In electric lighting they have sat on the fence, or doggedly opposed all progress. They have obtained Orders themselves, and sat on them rather than let others go on. Now that electric lighting is a proved success, the local authorities take it up themselves, even in small towns where it will hardly pay. But the chief evil here is that small local authorities will not take power from a power station, even if it is cheaper than they can generate it. The local councils want the patronage and the importance, and do not care for the interests of the ratepayers. Sometimes they oppose electric lighting because some of the councillors are shareholders in the local gasworks; sometimes because they run their own gasworks. The spectacle has been common of local authorities asking Parliament not to let power companies sell them power, because they want to generate it themselves. That is to say, the ratepayers are not to be allowed to get power cheap, because the councillors like the honour, and glory, and patronage of running a station themselves.

In traction work the veto of local authorities generally means either pig-headed and unreasoning obstruction, or a sort of blackmail. A company is not allowed to do anything unless it carries out all sorts of road widenings and local improvements, which ought to have been carried out by the local authorities themselves.

We fear the deputation will do little good. Parliament seems to be entirely under the thumb of the local authorities. They are well organised, and they are supported largely by the labour party. It is questionable whether the Government will do anything. Mr. Gerald Balfour rather put the deputation off with two Bills, which are to do something or other, and to be brought in some session—but not this session.

WAVE POWER.

WE have within the last few months received so many communications on the subject of wave and tidal power that it seems to be worth while to say a few words on a subject which appears to possess peculiar attractions for not a few ingenious men. It is, we suppose, impossible to look at a heavy sea tumbling in on a shelving shore without being impressed by the magnitude of the mechanical work done. When a gale sends home thundering breakers on a rocky coast the effect is yet more impressive. Indeed, few engineers can, we think, fail to feel a regret that these magnificent natural efforts should be barren of useful result. On the other hand, the quiet rise and fall of the tide in a great harbour is scarcely less suggestive. We see thousands of tons of shipping lifted up and suffered to fall again in the course of the day, and we are not surprised that many persons should hold that it is a pity so much energy should be wasted. Ought it not, for example, be possible to light such a town as Southampton by the mere rise and fall of the water in the docks and tidal basins?

Fortunately or unfortunately, as may be, appearances are in such matters very deceptive, and the power exerted is by no means so great as it seems. When we see how small a pair of engines driving a couple of centrifugal pumps will suffice to empty a large dock in three or four hours, we begin to realise the insufficiency of tidal power at all events to accomplish much. One pound of coal used to advantage will lift, in round numbers, one million pounds a foot high, or 100,000 lb., or more than 44 tons, 10ft. high. This represents 1540 cubic feet of water, and would nearly fill a tank 10ft. square and 16ft. deep. Let us suppose such a tank fitted to a dock, and that the rise of the tide is 20ft., the time 6 hours. The total work done would be 2,000,000 foot-pounds raised in 72 minutes, or 27,777 foot-pounds per minute, much less than 1 horse-power. Allowing for waste and loss of efficiency, we may say that twice the full of the tank with a fall of 20ft. would be required to develop 1 horse-power for six hours. But this is by no means the whole story. If the tank or float were 16ft. deep, the water in the docks must rise 16ft. before the float would be able to ascend with the full power due to its calculated displacement as given above. This contemplates a rise of water in the dock of 36ft. instead of 20ft. To avoid this the draught of our tank must be shallow, and its superficial area augmented in proportion. If anyone with a knowledge of mechanics will take paper and pencil in hand and try to work out a scheme for obtaining, say, even 1000 horse-power from a system of floats in a tidal dock, he will find that, having any regard whatever for the commercial aspect of the question, the work is simply impossible of achievement. The slow rise and fall of a number of tanks, or of one great caisson, extending over a period of twelve hours, must be converted into the rapid rotation of a shaft driving a dynamo. Mechanism can, no doubt, be contrived which would do this, but at what a cost of capital invested in plant and of power spent in overcoming the friction of gearing! Let us suppose the dock spanned by half a dozen gantries. On the gantries are cogged wheels, gearing into huge vertical racks, standing up like masts from the caisson which almost fills the dock. As the water rises, these racks cause the revolution of the geared wheels. These wheels are a little less, say, than 7ft. in diameter. They make one complete revolution per tide; that is to say, they turn round once in, roughly, six hours. How much gearing would be required to multiply this up to 150 revolutions per minute, the least that would be suitable for a dynamo? We fancy that the facts have only to be stated in this way to condemn a scheme of the kind once for all. We can assure our readers, nevertheless, that many patents have been taken out in the United States for utilising power in some such fashion as that which we have indicated—inventions which are not infrequently complicated by the addition of levers intended to multiply the amount of energy obtainable from the tide.

Inventors with better balanced minds have advocated the far more rational scheme of constructing vast basins or reservoirs, to be filled and emptied by the rise and fall of the tide, which will drive turbines or water-wheels. This, of course, is a refinement on the old tide mill. Several such mills have been built in this country and on the Continent, but they are very feeble things, of a few horse-power. The available fall cannot but be small, and when the fall is small an immense quantity of water is needed if any useful amount of power is to be had. In practice, 75 cubic feet of water, falling 10ft., would be needed per minute to get a single horse-power. For 1000 horse-power, not less than 75,000 cubic feet per minute, or 5,400,000 cubic feet per tide, must be provided. A reservoir 500ft. long, 500ft. wide, and 20ft. deep, is an object of some magnitude. It must not be forgotten, however, that inasmuch as the whole fall of 20ft. would not be continuously available, a very much larger volume of water would be required. An installation of this kind could not be constructed near a large town. Current could, no doubt, be sent from it over long distances. When we consider what the cost of sea walls usually is, we think enough has been said to show that this scheme also is chimerical, at all events so long as coal can be had at anything like the present price.

Although we have referred at the outset to wave power, we have reserved mention of it to the last. We have had various schemes for getting energy from the waves submitted to us. At one time inventions in this direction were patented in the United States at the rate of two or three a week. We have never yet seen one which possessed any commercial value whatever. There is a story told of an energetic American who erected a machine of the kind for pumping salt water up to a hotel to supply baths. The proprietor of the hotel stated that during the first week of its existence "it did not pump worth a cent." During the second week a moderate gale sprang up, and in a couple of hours the house was deluged with sea water. In the afternoon the whole affair was driven into the roadway as a wreck. We fancy that this gives a very fair idea of the probable career of any mechanism intended to utilise the somewhat boisterous play of breakers on a sea shore.

THE PARIS SEWAGE FARMS.

WHILE the populations in the neighbourhood of the Paris sewage farms have apparently accepted the inevitable, the usual half-yearly report presented to the Minister of Public Works continues to urge that all is for the best in this costly and much-criticised undertaking. Nevertheless, the Commission states that on both the farms at Gennevilliers and Achères the Paris municipal engineers are carrying on experiments with the bacterial system; but it affirms that, up to the present at any rate, "the results do not justify any too great illusion as to the value of this process, which can probably be utilised in conjunction with earth filtering, but cannot replace it." According to the Commission the method of purifying sewage by filtering it through the soil has proved to be the best, because it allows of the water returning to the river absolutely free from microbes, while this has not been found possible with the water from the bacterial tanks. In support of this contention the Commission refers to a recent report of the Public Health Committee of France, which states that the bacterial water can only be diverted into the rivers in cases where it is not drawn upon for consumption. The objection raised by the opponents of the sewage farms has always been that the sewage polluted the wells, and it will be remembered that two or three years ago the water supply in a vast district at Carrières and Méry was poisoned in this way. The municipal engineers, however, urged that this was due to temporary causes, and chiefly to the fact that considerably more sewage was being sent on to the farms than had been provided for. Since that time the quantity has been reduced, and during the second six months of 1901 the 900 hectares at Gennevilliers received 21,121,040 cubic metres of drainage water and sewage, and for the whole year the quantity was 40,140,877 cubic metres, representing 44,600 metres per hectare. The amount provided for was 40,000 cubic metres; but the Commission states that the excess of sewage has not caused the slightest inconvenience. During 1901 the total area irrigated was 5500 hectares, comprising 900 hectares at Gennevilliers, 1300 hectares at Achères, 2150 hectares at Méry and Pierrelaye, and 950 hectares at Carrières-Triel. The total quantity of drainage water and sewage pumped from the collectors during the year was 228,416,847 cubic metres, including 18,250,000 cubic metres from the department of the Seine. Of this amount 202,246,255 metres were sent to the sewage farms, and the remainder diverted into the Seine at Clichy and at La Chapelle. At the time the Clichy collector was closed with a good deal of official pomp it was announced that henceforth no sewage would go into the Seine; but the report shows that more than 26,000,000 metres are still diverted into the river every year. It is true that of this amount Paris is only responsible for 8,000,000 metres, and the Commission states that the Municipal Council hopes to be able to treat this before long by extending the farms at Méry and Achères and acquiring properties elsewhere.

THE YORKSHIRE MINERS AND THE REDUCTION IN WAGES.

THE Yorkshire Miners' Association, the most powerful combination of its kind in the country, held its annual demonstration at Rotherham on the 16th inst. In spite of the unfavourable weather, over eighty thousand people were present. It was held on the day that Lord James of Hereford gave his decision as independent chairman of the Conciliation Board, on the representations of the coalowners that the condition of trade warranted a reduction in wages. His lordship has decided in favour of the employers, with the result that there is to be a 10 per cent. reduction as from the 1st July. It is evident, from the speeches made at the demonstration, that Lord James' decision had been anticipated, and therefore gave no surprise. Mr. Benjamin Pickard, who is the secretary of the Association and also the president of the Miners' Federation of Great Britain, stated that he had always opposed arbitration in regard to wages, but the men had adopted the principle, and Lord James of Hereford, having given his decision, it was their duty to abide by it. "If the decision," he said, "goes against the grain you must take it like men and prepare for worse things that may come hereafter." Mr. Pickard at the same time contended that, though a day of reduction was inevitable, it was yet too early for it. He reminded them of what he had said, that in 1900 colliery owners made as much money as would provide for twenty-five generations, and he was still of that opinion. He qualified this statement, however, by saying that he did not mean it to apply where there might be 2000 shareholders, but where there was a colliery company, with a limited number of directors, there was no doubt the money received during the past four years was equivalent to that. Resolutions were passed at the various platforms expressing satisfaction with the increase of the members of the Association and of the funds, and covering a wide range of other subjects, including the Eight Hours' Bill, the Mines Amendment Bill, the Workmen's Compensation Act, old age pensions, &c. The demonstration deprecated the passing into law of clauses in the

Workmen's Compensation Act permitting employers to contract out of its provisions, and whereby insurance and indemnity societies are allowed to interfere with the carrying out of the statute. The miners also strongly deprecated the alleged *ex parte* schemes certified under the Act, and expressed strong approval of the action taken by the officials of the Miners' Federation in drafting a Bill amending the Workmen's Compensation Act of 1897. All miners were further called upon to do everything in their power to get passed into law an old age pension scheme "which should give adequate relief to those unable to continue work, through whatever cause arising, in the mining population." The speeches of the various miners' leaders were remarkably candid, and the colliers received the counsel to observe loyally Lord James' decision in a spirit which promises well for prolonged peace in the coalfield, even after the Conciliation Board arrangement expires in 1904.

THE TAFF VALE CASE—MR. HOLMES'S COSTS.

WE have not reached the end of the quarrel between the Taff Vale Railway Company and the Amalgamated Society of Railway Servants. The very important decisions which that case has so far been the means of supplying were only interlocutory. The action remains to be tried out to determine the liability or non-liability of the Society to pay damages to the Railway Company. Now, the Society has, of course, long ago become alive to the fact that it is essential on its part to show that the acts of Mr. Holmes, its local secretary at Cardiff, of which the Railway Company complains, were unauthorised by the Society, that Mr. Holmes exceeded his duty as its officer, and that the Society is not responsible for them. This defence it has, in fact, put forward. But at the same time a resolution was passed that Mr. Holmes should be provided at the cost of the Society with legal assistance; in other words, that while dissociating itself in every way from Mr. Holmes and repudiating him upon the record, he should be indemnified against all the consequences of his acts. This did not suit some of the members of the Society itself. They considered that the latter had no power under its rules to spend money in this way, and they brought an action against the trustees of the Society to restrain the contemplated appropriation of its funds. In this action, Alfin *v.* Hewlett, Mr. Justice Joyce has granted the injunction for which application was made; and if it stands good, Mr. Holmes will have to defend the Taff Vale action against him at the cost of himself, or some person or body of persons other than his Society.

THE ROYAL SOCIETY.

THE conversazione of the above-named Institution, held at Burlington House on Wednesday evening, was not remarkable for the number of exhibits of engineering interest, and many of the other scientific objects had already done service at this and other functions during the present season. The liquefaction of gases, to which much attention is being given, was well exemplified by a practical-looking apparatus shown by Dr. Morris W. Travers. The object of the appliance is the liquefaction of hydrogen, and we were informed that it is capable of giving about half a litre per hour. A peculiar characteristic of this gas is that when it is compressed at the ordinary temperature and allowed to expand it becomes warmer, while air under the same conditions becomes colder; at temperatures below −80 deg. Cent. hydrogen becomes an imperfect gas, in the same sense as air, and undergoes cooling on free expansion—Joule-Kelvin effect. The gas, under a pressure of 120-150 atmospheres, passes through coils in the interior of the apparatus which are cooled in solid carbonic acid and alcohol (−78·5 deg. Cent.), in liquid air (−185 deg. Cent.), and in liquid air boiling under reduced pressure (−200 deg. Cent.). It then enters a regenerator coil, and, expanding at a valve at the bottom, is partially liquefied. The liquid collects in a vacuum vessel at the bottom of the apparatus; the unliquefied gas passes upwards through the regenerator coil, cooling the gas it contains, and returns to the compressor.

Professor H. L. Callendar, F.R.S., exhibited several appliances. First, a simple apparatus for determining the mechanical equivalent of heat. This consists of a brass cylindrical box, 2in. wide by 6in. in diameter, which turns by a handle or motor on a horizontal axis. Weights in the ratio of about 2 to 1 are suspended from the two ends of a belt passing over the box. The belt is made partly of thin steel and partly of leather, having different coefficients of friction, so that it takes up a steady position of equilibrium automatically when the box is turned. The equilibrium is practically independent of the speed, and the weights may be varied within wide limits. The thermal capacity of the apparatus, when half full of water, is about 500 calories per degree, and the temperature may be raised by 10 deg. Cent. in 1000 revolutions. At this rate of working it is claimed that the external heat loss is a relatively small percentage of the heat generated, and may be accurately measured by making trials with different weights. The rise of temperature was indicated by a platinum thermometer recording automatically on a drum with a scale of 2 centimetres to 1 deg. Cent., but a mercury thermometer suffices. With a platinum thermometer it is possible to measure the mechanical equivalent to one part in a thousand, if a water jacket is employed to keep the external conditions steady.

The other exhibits were vacuum-jacketed calorimeters. These calorimeters are of the type designed for measuring the variation of the specific heat of water and mercury, but embody more recent improvements. The external heat loss is reduced to a minimum by the employment of a glass vacuum-jacket hermetically sealed and silvered internally. A silvered calorimeter of the same type recently employed for measuring the specific heat of steam was shown fitted up in its copper steam jacket. Another, unsilvered to show the interior, exhibits the heating coil and platinum thermometers *in situ*. Other special devices are required for regulating the steam current and drying the steam.

Mr. W. R. Pidgeon had on view a new electrical influence machine suitable for campaign work. The discs are mounted in sets of three, and have inductors placed outside the first and third. The central disc revolves in the opposite direction to the other two. Any number of these sets of revolving discs, together with their inductors, can be arranged close together on the axis to give a more powerful machine.

The sectors are embedded in "volenite," and there is no glass or wax used in the machine, so that it will resist hard usage. Mr. Henry Crookes and the West Indian Volcanoes Committee of the Royal Society showed specimens and photographs of volcanic dust from the West Indies. Mr. J. Y. Buchanan gave a demonstration with lantern slides illustrating the performance of M. Santos Dumont's airship, and the accident to it on February 14th last.

DOCKYARD NOTES.

THE cruiser Doris has replaced the Arrogant in the Channel Fleet.

QUITE a small naval review has been held at Plymouth this week. Anchored in the Sound are the Japanese Asama and Takasago, the Chilian cruiser Chacabuco, as well as two Chilian transports and three torpedo craft. As all the larger vessels hail from Elswick, some wag has christened it the Elswick exhibition.

THE new armoured cruiser Cornwall is to be attached to the Devonport command. So far as our four dockyards will allow, it appears intended to make the County class local ships. This is a good idea, but it is easily turned into a bad one. So far the County connection has not "caught on" to any great extent; it is hardly likely to do so until the ships have some more tangible existence than most of them yet possess.

A COMPLETE list of foreign ships to be at the naval review is as follows:—Sweden, Oden; Norway, Norge; Russia, Pobieda; France, Montcalm; United States, Illinois; Germany, Kaiser Friedrich III.; Italy, Carlo Alberto; Japan, Asama and Takasago; Denmark, Herluf Trolle; Portugal, Dom Carlos I.; Spain, Emperado Carlos V.; Holland, Holland; Greece, Psara; Austria, Szigetvar; Chili, Chacabuco; Argentine, Presidente Sarmiento. Of the above eighteen, six were built in this country, five by Elswick and one by Laird's, of Birkenhead. Twelve of them have water-tube boilers.

LIFE in French submarines is not apparently "all beer and skittles." The submarine Silure recently went out on trial and the crew began to get insensible. "Whereupon," says the French paper from which we quote, "several of our brave sailors began to ask, Is all well?" The answer apparently was in the negative, so the rest went homeward, with three men well nigh suffocated.

THE "new" Japanese shipbuilding programme is announced. As, however, it does not begin till the year after next and then runs for five years, it is somewhat premature to discuss it now. Whatever may be settled to-day is pretty sure to be altered ere 1904, by which date both battleships and armoured cruisers may have given place to intermediates.

MR. CHARLES DE GRAVE SELLS writes to us in connection with some recent remarks in this column about Ansaldo's yard at Genoa, disclaiming any share in making its prosperity, save in so far as the engine works are concerned. He wishes us to place the credit on Colonel Soliani, late of the Government Corps of Naval Architects, as the chief of the yard. Whoever is responsible for it, there is no doubt that Ansaldo's yard has made its mark, and we hope Mr. Sells will allow us to congratulate him on the 17·5 knots got out of the reconstructed Turkish Messoudiyeh at her recent trials. Later on we hope to deal *in extenso* with this ship, which certainly bears the palm for the most out-and-out reconstruction on record. We might do worse than imitate it with our old Superb and Alexandra.

THE INDUSTRIAL USE OF ALCOHOL.

IN Peru, alcohol, being a product derived from the manufacture of cane sugar, can be obtained at a trifling cost, and its production by far exceeds the present consumption of the country. In order to render its use more general for industrial purposes, the Government of Peru has resolved that an exhibition shall be held in the capital of the Republic, Lima, of motors and of the most perfect apparatus which use methylated or denatured alcohol as the means for producing motive power, heat, and light. There is reason to believe that once the public has the opportunity of practically judging the present condition of these modern appliances, hitherto unknown in the greater part of the country, the object in view will be attained; and at the same time a new market, that of Peru, will be opened for the sale of motors and apparatus. The exhibition will be held in the principal building and pavilions of the municipal parks in Lima, in accordance with the following regulations:—

(*a*) The exhibition of motors and apparatus for which neutralised or methylated alcohol is employed will consist of five divisions, with their corresponding sections, in the following form:—

First division.—First section: Stationary motors for general use. Second section: Special motors for agricultural purposes. Third section: Marine motors, motor cars, and locomotives. Fourth section: Locomotors. Fifth section: Carburisers.

Second division.—First section: Heaters for general use. Second section: Heaters for railway cars, coaches, &c. Third section: Calefactors. Fourth section: Stoves and other apparatus for heating purposes.

Third division.—First section: Lamps or apparatus on the incandescent system for the lighting of streets, squares, piers, public buildings, theatres, workshops, &c., by means of methylated or neutralised alcohol. Second section: The same, by means of carburised alcohol. Third section: The same, by the usual bright flame system, by means of carburised alcohol. Fourth section: Lamps or apparatus on the incandescent system, for domestic use, by means of neutralised or methylated alcohol. Fifth section: The same, by means of carburised alcohol. Sixth section: The same, by the usual bright flame system.

Fourth division.—First section: Methods of process of neutralising or methylating or denaturing the alcohol. Second section: The same for carburising the alcohol.

Fifth division.—Utensils and apparatus not comprised in the foregoing classifications, and which make use of neutralised, methylated, carburised, or solidified alcohol.

(*a*) The prizes will consist of gold, silver, and copper medals, as well as of awards of honourable mention.

(*b*) For each section there will be awarded one gold medal, two silver, and three copper medals, besides five awards of honourable mention. The prizes and honourable mention will be awarded by a jury, assisted by a technical commission of seven members, appointed by the Government in view of the special knowledge and experience possessed by each one of them as regards the various sections comprised in the exhibition. The jury will be composed of three delegates of the Government, two of the National Agricultural Society, two of the National Society of Industries, and two others appointed by the exhibitors themselves or their representatives. In order to ensure the greatest accuracy, the jury will be subdivided into five commissions, each one formed of three of its members, and each commission will proceed to examine each one of the five divisions in which the exhibition is organised. The commissions will present their respective reports to the jury, and in view of these reports that body will give its decisions in accordance with the majority of votes. The jury, having before it the articles exhibited, has the power to fix the sub-sections which it may judge convenient, in order to attain a correct distribution of the prizes, and considering asan entire section each one of the sub-sections, as far as regards the recompenses.

(*c*) The exhibition will be inaugurated on the 1st of November, 1902, and will be closed on the 30th of same month; and on this latter date the prizes and respective recompenses will be awarded.

(*d*) The executive committee will attend to the installation of the objects intended for exhibition, free of all expense, whenever requested to do so by the interested parties, and will bear in mind all suggestions received from them.

(*e*) The executive committee will provide the exhibitors gratuitously with the space required for the installation of their exhibits, in the principal building, or outside of it, within the precincts of the municipal parks, if this be expressly requested. It will also provide gratis the necessary lighting and water; besides which, if the committee think it convenient, it will also provide the alcohol necessary for the working of the motors and other apparatus exhibited.

(*f*) The exhibits intended for the exhibition should be placed within its precincts, at the latest, during the month of September, 1902.

(*g*) In order to ensure the admission of the exhibits, and obtain the concessions, reduction in freights to which are granted to the exhibitors, it will be necessary to address directly in writing the executive committee, or to do so through the Peruvian consuls or through the special agents appointed. The aforesaid communication must contain:—(1) The name and residence of the exhibitor. (2) The nature and use of the objects to be exhibited. (3) The division and section to which these correspond. (4) The superficial area required. Printed forms and requests for admission can be obtained from the Peruvian consuls or special agents.

(*h*) Practical experiments with the motors, apparatus, and other exhibits will be made during the thirty days previous to the inauguration—October, 1902—in accordance with the general rules already laid down. The jury will advise the exhibitor, or his representative, three days previously, the day and hour, when the experiment will take place of the motors, apparatus, or other objects exhibited by him.

(*i*) The exhibitors must, as regards the putting in motion of their exhibits, submit to the rules laid down by the executive committee, which has the direction of all matters pertaining to the maintenance of order and general vigilance.

(*j*) No exhibit can be removed during the thirty days of the exhibition, during which term the exhibitors can sell the objects exhibited; but in this case the corresponding Custom House duties will have to be paid. The time allowed for the removal of the exhibits is during thirty days following the closure of the exhibition, that is, throughout the month of December, 1902. The exhibitors who may not find it convenient to re-export immediately their exhibits, can petition their removal and offer for sale in the building of the permanent exhibition of machinery and manufactures, under the care of the Government employés who attend to that department. The exhibits may remain for six consecutive months in that department, without any charge whatever to the interested parties; it being understood that sales made during the above-mentioned interval will be subject to the payment of the respective Custom House duties. At the expiration of the term of six months the exhibitor must withdraw his exhibits and pay the Custom House duties upon them, in case he should not decide to re-export them immediately.

(*k*) The secretary of the executive committee will provide the exhibitors with all the information they may desire, and will give his attention to all matters relating to them; all complaints should likewise be addressed to him, in order that through him they may be duly submitted to the executive committee.

(*l*) A book will be published containing all the documents relating to the exhibition, and with engravings and the necessary explanations, in order to popularise in Peru and South America the use of alcohol as fuel in its various applications to the different industries.

(*m*) In order to render every facility for the importation of the various exhibits, and that the exhibitors may take advantage of all the facilities offered them, the bills of lading should be made out to the order of the executive committee and the packages marked as follows:—

$$\frac{\text{E DE A}}{\text{Callao}}$$

(*n*) Every exhibitor has a right to ask that in the aforementioned book (see *l*) an advertisement be inserted of his exhibits in the form he may express and without any charge.

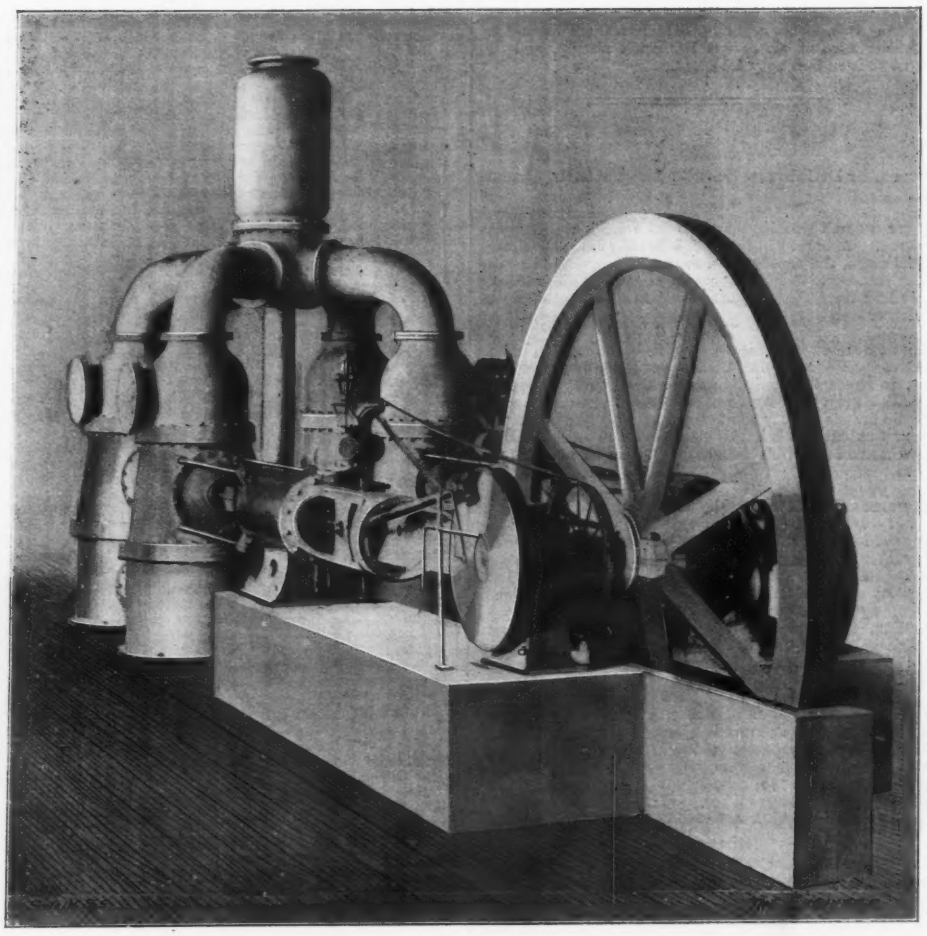
For further information, address José Balta, Lima, Peru.

ENGLISH RAZORS IN POLAND.—The official organ, *Warschawski Dnevnik*, says that recently there have appeared in Warsaw razors of "local make" which seemed in every respect quite as good as the famous English-made razors. There was no little jubilation at this evidence of the great progress made by the native industry. But this justifiable gratification was suddenly checked by the discovery that a Berlin cutlery firm, wishing to drive English razors out of the Polish markets, ordered a large supply of English razors which were to be delivered without bearing their place of origin. When these razors were sold in Poland the name of the Polish dealer was stamped upon them before they were delivered, and the Poles thought they were buying home-made razors.

CONCRETE-LAYING MACHINE.—In laying concrete foundations for streets and tramways, the concrete—whether mixed by hand or machine—is usually handled and deposited by a gang of men with wheelbarrows. In the United States machines have been adapted to this purpose, and in streets where a tramway has already been laid the machine may be run on the rails. One of these machines consists of a steel underframe mounted on four wide-tired wheels and having at the front end an inclined frame for a belt conveyor 20in. wide. The lower end of this frame is carried by a third pair of wheels, and has a steel box or hopper for materials. At the middle of the underframe is a 12 horse-power gasoline engine, while at the rear end is a concrete mixer. Pivoted to the rear end is a 20ft. steel boom, supported by wire rope guys from a gallows frame, and carrying a 20in. india-rubber conveyor belt. Inclined planes are placed on each side of the front pair of wheels, and the cement, sand, gravel, and stone are carried or wheeled up and dumped into the box already mentioned. When the proper proportions have been deposited the bottom is opened by a lever, and the materials fall upon the conveyor belt, which carries them up to the head of a shoot, through which they are discharged into the mixer. As the concrete emerges from the mixer it falls upon the second conveyor belt, from which it falls directly upon the street surface. The machine propels itself slowly along the centre of the street, and a man swings the boom slowly to and fro so as to cover the entire width of the street with the proper thickness of concrete. The machine now in use weighs about 9 tons, and will deliver about 200 cubic yards per day. A similar machine running on rails, and with the boom inclined so as to raise the concrete, is used for depositing concrete in the forms for long retaining-walls or railway work.

STEAM PUMPING ENGINE

GEORGE FLETCHER AND CO., DERBY, ENGINEERS



INJECTION WATER-PUMPING ENGINES.

WE illustrate herewith a pair of pumping engines of a somewhat uncommon type which have recently been shipped to Fiji by George Fletcher and Co., of Derby. They have been made to the order of the Colonial Sugar Refinery Company, of Sydney, and they are for the purpose of supplying a large sugar factory with water. The peculiar construction is easily seen from the engravings. The plungers are 20in. in diameter, and have a 36in. stroke, and the pumps are designed to discharge 240,000 gallons per hour against a total head of 56ft. The pumps are driven direct by high-pressure steam engines.

Each pump is built in sections, and the design lends itself to the providing of large areas through the suction and delivery valve seats; the total area through the suction being

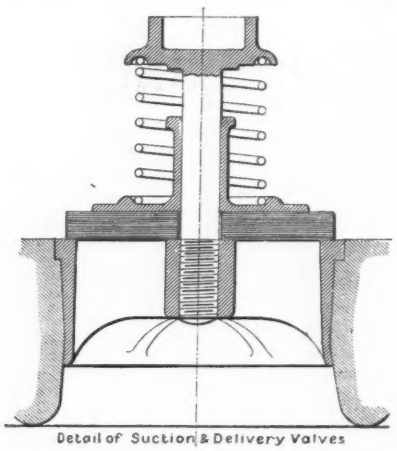


Fig. 1

480 square inches, and through the delivery 280 square inches. The construction of the valves is shown in Fig. 1. The discs are made of rubber. The plungers are of gun-metal, and work in long gun-metal bushes or sleeves. Arrangements have been made by which one side of each pump may be isolated for repairs or inspection while the other side is at work. As will be seen from Fig. 2, the waterways are long and free from air pockets. The pump rods are of steel sheathed with gun-metal, and they are coupled direct on to the piston-rods—which are carried through the backs of the cylinders—by means of screwed clamps held together by four bolts. These clamps, as will be seen, are made in halves, to admit of their being removed with the least amount of trouble. The pump bodies are bolted to wings on the engine cylinder bodies by means of four distance bolts.

The engines are of the ordinary Corliss girder type, having cylinders 19in. in diameter, and 36in. stroke, and they are fitted with slide valves. The makers inform us that they have paid special attention to giving large surfaces to all wearing parts, and to the design generally, with a view to reducing as far as possible the chance of engines giving any trouble when at work. Nevertheless, we should have thought that the piston and connecting-rods and the distance bolts between pump and engine were decidedly on the light side.

THE CANAL OF THE TWO SEAS.

UNDER the above title an old maritime project, surpassing in magnitude and importance all similar engineering undertakings, has been revived and is at present under serious consideration in France. It has for its object the construction of a canal from the Atlantic to the Mediterranean, or localising the route more precisely, from the waters of the Gulf of Lyons to the Bay of Biscay. The southern entrance of this magnificent inland waterway will, it is proposed, be at Narbonne. After gaining the basin of the Garonne, which it will follow for a certain part of its course, it will take the line of the Gironde to its mouth. It will have a total length of 312 miles. It may be here stated, for the sake of comparison, that the lengths of the best known ship canals are as follows:—The Suez, 98 miles; the Baltic, 61; the Manchester, 35; the Terneuzen, 20; the Amsterdam, 16; the Bruges, 8; and the Corinth, 4 miles. Of all these, the Suez and the Corinth are the only two which have open channels, completely unimpeded by locks. The Panama Canal was intended to have a length of 46 miles, and 170 miles is the length of the course marked out for the Nicaragua.

Apart from the magnitude of the projected undertaking, it possesses a very considerable amount of interest, not only for ourselves, but also for the rest of Europe. Once constructed, it would be no longer necessary for the fleets of the northern European Powers to run the gauntlet along our shores to reach the Mediterranean. The importance of Gibraltar would be seriously diminished. The western gate of the great sea would no longer be all ours. What the Baltic Canal is to Germany, so would that of the two seas be to France, but to a much greater extent. It is estimated that in a voyage from Havre to Marseilles and Genoa, *vid* the French Canal, there would be a saving of about a thousand miles, in comparison with the present route through the Straits of Gibraltar. All ships voyaging from northern ports to the Mediterranean and the East would benefit to the same extent.

Owing to the great differences of level encountered along the course of the proposed maritime works it is not possible to avoid the introduction of locks. Their number is rather formidable, amounting as it does to twenty-six. But even allowing from half to three-quarters of an hour for a big ship to get through, the time lost would not appreciably affect the saving between the two above-mentioned routes. It will be allowed that the security of the transit through the canal is a consideration and counts for something, although not to quite the same extent as it would have done in the days of sailing ships. Great ship canals may be regarded from two general points of view—a strategic and a commercial one. In the present instance there may, perhaps, be doubts respecting the future financial success of the scheme, but none regarding its great strategic value and importance.

It is worth noting that the sinister predictions that the Baltic Canal would possess no commercial value have been completely falsified. Yet this was in every sense a military canal. It was commenced in 1886, and opened for traffic a few years afterwards. It was not, however, until the year 1900 that, for the first time, the receipts paid the expenses, amounting to £105,000. It is expected that when the returns for last year are compiled, the revenue will exceed the expenditure by about £10,000. Nothing is received from the passage of men-of-war, as they are not liable to navigation dues. The promoters of the great French enterprise are employing all their efforts to obtain an official declaration that the construction of the proposed canal is *d'utilité publique*. That once accomplished, the first step, which costs so much, is removed, and the actual prosecution of the work materially facilitated. The cost of the whole undertaking, which at present can be but approximately estimated, is put at fifty-two millions of our money.

EUSTACE SMITH.

THE death is announced as having taken place on Saturday last in London, of Mr. Eustace Smith, of Longbenton. Mr. Smith was born in 1861, and he was the surviving partner of the firm of T. and W. Smith, at one time shipbuilders at St. Peter's, and a firm who are now shipowners and steel wire rope makers on an extensive scale, making largely for colliery and cable car work. The ropery business is one of the oldest in the North, having been established in 1784. Mr. Smith was also chairman of the Smith Dock Company, which now owns all the largest docks and pontoons in North and South Shields. A year or two ago he acquired the shipyard and business of Edwardes Bros., and at the same time extended the shipbuilding premises of the Smith Dock Company in North Shields for the building of steam trawlers and herring drifters; and the combined concerns were merged under the title of the Smith Dock Company, which is now one of the largest producers of this class of craft in the country, turning out up to twenty to twenty-five steam trawlers and herring drifters per annum.

Tyneside will keenly feel Mr. Smith's loss, for he has done much for its welfare. His enterprises were all successful, being excellently managed; he was known for his capacity and for honesty in business, and as a local authority says, "He is one of the men who will be missed."

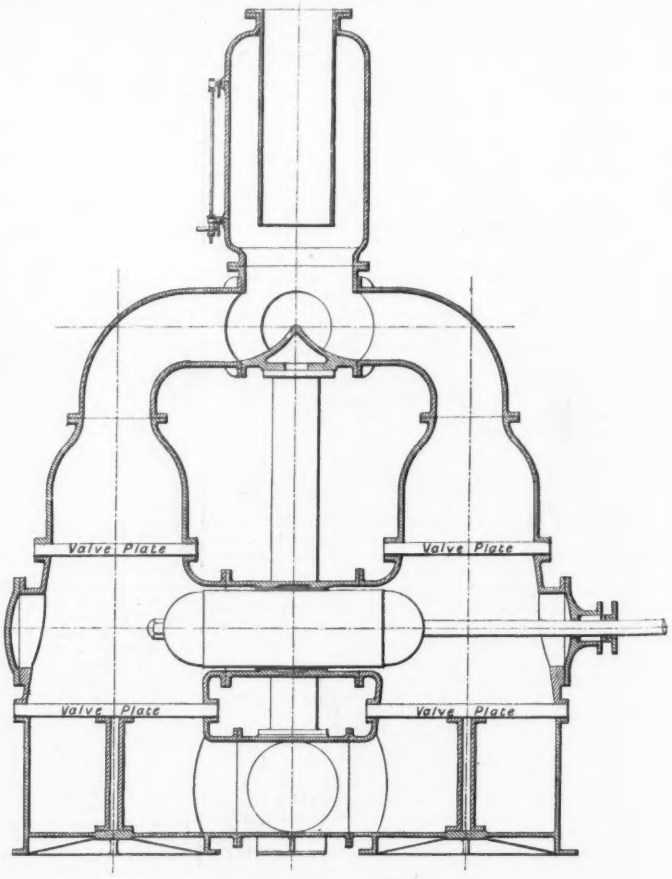


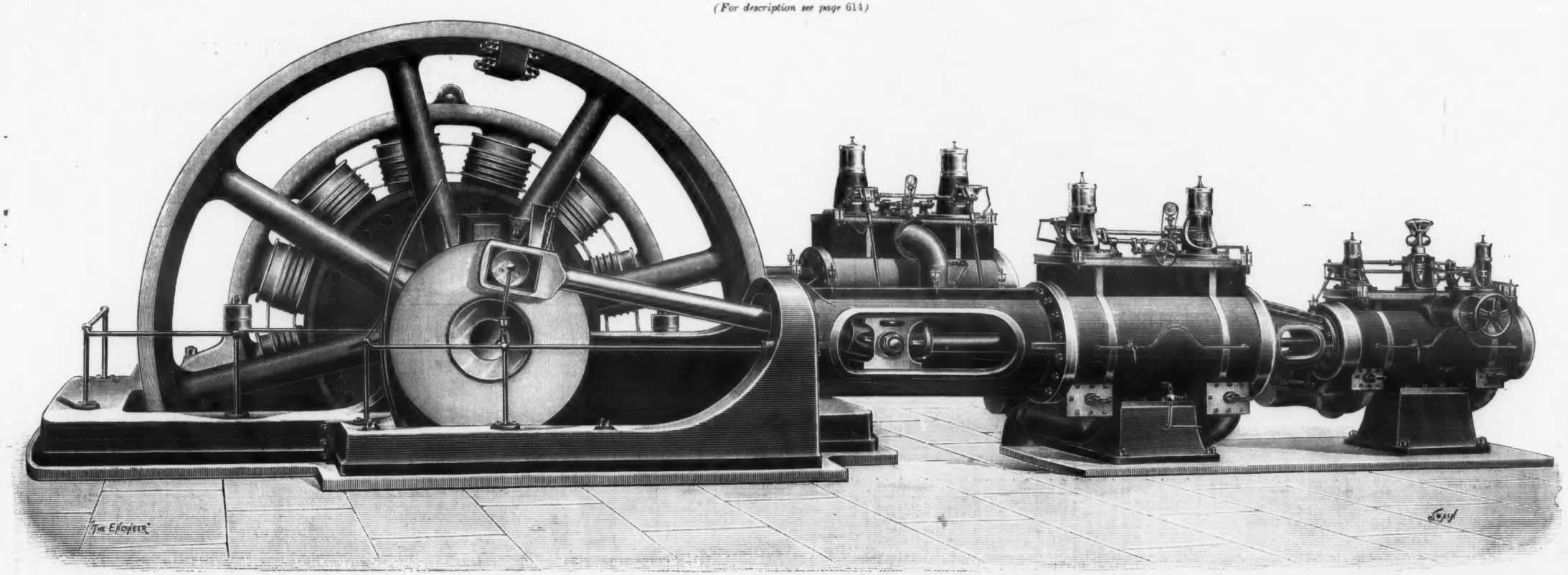
Fig. 2—SECTION OF PUMP

A PAPER was recently read before the Paris Academy of Sciences on the "Specific Inductive Capacity of Dielectrics at Low Temperatures," by MM. Jacques Curie and P. Compan. It appears that the soakage effects in glass tend to disappear at low temperatures. The dielectric capacity varies as a linear function of the temperature, the temperature coefficient being determined for glass, ebonite, mica, and quartz.

TRIPLE-EXPANSION ELECTRIC LIGHT AND POWER ENGINE

ROBEY AND CO., LIMITED, LINCOLN, ENGINEERS

(For description see page 614.)



THE ROYAL INSTITUTION.

At the Royal Institution on Friday evening last Mr. Marconi delivered a most interesting discourse on "The Progress of Electric Space Telegraphy." As was the case when he delivered his last discourse before the Institution, something, whether the fascination of the subject or the charm of his manner—perhaps a combination of both—secured for Mr. Marconi an exceptionally large audience. Those who faced a most inclement evening in order to attend were not disappointed, for the discourse throughout was full of interest. Mr. Marconi at the outset remarked that wireless telegraphy was at the present time probably attracting more world-wide attention than any other practical development of modern electrical engineering. The subject, at first sight, appeared almost to savour of magic, and yet, when one came to consider the matter, it was in reality no more wonderful than the sending of messages along wires, and the making of the electric current to traverse all the convolutions of wire in intricate electrical apparatus. Light waves were familiar to all. All gifted with sight could see the light coming from stars situated millions of miles away. Why, therefore, should not electric waves be also appreciable at a distance? Wireless signals, indeed, may be ranked among the first messages sent to one another by mankind. The savage lit a bonfire on a hill. The light was propagated by waves in the ether, and was seen by other savages a long way off. There was a pre-arranged code; those who saw the fire knew what it meant. The message had been sent. The wireless telegraphy of to-day, while being similar in some respects to this form of signalling, possessed the difference that it depended upon a comparatively new way of controlling and detecting certain waves much slower in their rate of vibration than light waves. These waves, as, no doubt, most of his hearers would know, were called Herzian waves, after their discoverer. And here we may be permitted, perhaps, to make a general remark upon Mr. Marconi's discourse. All the way through it he gave, whenever occasion required it, ample honour to those, whether dead or living, or of whatever nationality, who had done anything, however slight, to advance the cause of wireless telegraphy or experimented in the direction of sending messages through space. Modesty is apparently a virtue possessed in large measure by Mr. Marconi, and it was pleasing to hear the generous tributes made to the skill and perseverance of his assistants.

Mr. Marconi, after the preliminary remarks to which we have alluded, proceeded to discuss the original methods which he had employed in producing and receiving the Herzian waves. At first the primary of a sparking coil was connected through a battery with a contact key, the terminals of the secondary winding being connected one on either side of a sparking oscillator, one terminal of which was also connected to earth, while the other was taken by an insulated wire to an aërial mast. The waves had been received by means of a coherer, one terminal of which was connected to earth, and the other to an aërial line similar to that at the sending station. In conjunction with the coherer there was a local circuit, by means of which the messages were recorded. We need not follow Mr. Marconi through his description of the coherer; it is familiar to the majority of our readers. Suffice it to say, that the best results are obtained when the resistance of the coherer, in the absence of Herzian waves, is practically infinite when measured with a small electromotic force.

Mr. Marconi explained that the appliances he first used were successful, but he quickly realised that some method of "tuning" must be devised if a number of different stations were wanted to work without interference. He soon found when using tuned instruments that the aërial conductors, so useful with untuned transmitters and receivers, were a disadvantage. The aërial wires were such good conductors that all the electricity had escaped from them before oscillations had had time to be set up. For success in this direction it was necessary to have the accumulated effect of a large number of small impulses properly tuned. As Prof. Fleming had expressed it, when speaking of starting a pendulum by means of puffs of air, it was necessary not only to time the puffs correctly, but to go on puffing. Exactly the same principle applied to working "tuned" apparatus in wireless telegraphy. The aërial wire so suitable for working where no tuning is required became impracticable when it is so required. It had become necessary, therefore, to devise some apparatus where the oscillations might be slowly damped, and which might have a decided period of its own. Such an apparatus was found in a zinc cylinder some six metres high and one and a-half metres in diameter. With it signals had been sent from St. Catherine's Point in the Isle of Wight to Poole—a distance of 30 miles—the messages being so "tuned" that they were not interfered with, nor could be read by other instruments in the vicinity. There were the naval stations at Portsmouth, and the various men-of-war at Spithead, which were nearer to St. Catherine's than Poole, but they remained unaffected. Indeed, it is within our own knowledge that attempts were made during the early experiments with the zinc cylinder to upset, interfere with, or intercept messages sent by means of this apparatus. These attempts were made from a point not more than half-a-mile from the St. Catherine's Point sending station. We understand that the messages remained entirely uninterfered with, and it is to be gathered from the fact that nothing was heard of these counter experiments that no success in the way of intercepting was obtained.

In the Navy experiments had been made with condensers in connection with aërial radiators, with good results. The tuning was made more marked when, in addition to a condenser applied to the induction coil, the coherer itself was shunted with a condenser. The capacity of both these condensers being variable, a large range of variation could be obtained. So very sensitive is the instrument to gradation of tone that we have heard of a case where when one man formed part of the circuit the messages were received, whereas with another man in the same part of the circuit the instruments gave no sign. The varying capacities of the two bodies were sufficient to make this difference. Having obtained this ability to pick and choose, as it were, the next step to be attained was that of having several transmitters and receivers, differently timed, but only one vertical rod—a sort of multiplex arrangement—and this had actually been achieved. A still greater amount of sensitiveness had been arrived at when there was a combination between the zinc cylinder and oscillators provided with adjustable condensers.

Up to now ships had none of them been fitted commercially with tuned instruments. It had been considered all along that the great object of having wireless apparatus on vessels was to enable signals of distress to be sent to the shore or to other vessels, though these might not even be in sight. Such a result could not be obtained unless all the instruments responded to the same note, as it were. So Mr. Marconi's long-distance experiments had been carried out without fear of affecting vessels which might be within the radius of effect, since the instruments he employed were tuned. Thus, from his powerful Cornish transmitting station, where a 40 horse-power dynamo provides the electricity, Mr. Marconi can send signals which, under favourable circumstance at any rate, can be read in America; while Lloyd's wireless station at the Lizard—a few miles away—remains unaffected. Mr. Marconi remarked that he was not prepared to say that under all circumstances tuned messages could not be interfered with, but he did say that a great number of variously-tuned systems could be at work simultaneously without

interference. The nature of the coherer was then dealt with at some length. It was, as the lecturer explained, the detector of electric waves—the electric eye of the apparatus. The particular form which he preferred was a glass tube about four centimetres long, with metal or carbon blocks as terminals, with nickel and silver fittings between them. An essential feature with such forms of coherer is that the tapper should do away entirely with conductivity. This, supposing the coherer to be in parallel with a condenser, was easy of explanation, since with a low-resistance coherer the condenser would be short-circuited. Very fine filings must be used also, and the gap must not be too small. There are some kinds of coherers which do not require tapping, those made with carbon, for example. The use of these under some circumstances means increased speed of sending, since the mere fact of having to tap means sluggishness. With the carbon form of coherer, and with all other "self-restoring" coherers or detectors at present invented, it had only been possible to receive signals with telephones. At present it had not been found possible to actuate recording instruments. An interesting form of self-restoring coherer had been invented by the *personnel* of the Italian navy. In this there was a glass tube with two plugs of iron or carbon, having between them a globule of mercury. Self-restoring coherers had so far not been satisfactory commercially, but had been most useful for experiments when tuned effects were not wanted. Mr. Marconi also described an electro-magnetic detector which he had invented. It was more sensitive and more reliable than the coherer of whatever form, and it did not require so many precautions in working. It had, however, to be worked with a telephone. It consisted of two coils of insulated wire placed one inside another, and close by two permanent magnets. Two forms were shown, one in which there was an endless band of soft iron wire, moving inside the inner coil of wire, and the other, on which the magnets themselves were moving. The ends of the core wire were connected, one to the aërial conductor, and the other to earth. The ends of the other coil of wire were connected with the terminals of a telephone. It was essential, in order that messages might be received, that the core in one case, or the magnets in the other, should be moving. At present it was possible to send thirty words a minute, but with this apparatus Mr. Marconi, who does not, as a rule, attempt to prophesy unless he is sure, says that the speed may be expected to reach several hundred words a minute. As to the theory of the action of this apparatus, he thinks the working is due to the fact that Herzian waves in some manner alter the hysteresis of the iron, causing jerks in the currents passing.

After having given details of the developments in his system during the last few years, Mr. Marconi went on to detail his Transatlantic experiences, of which our readers are already aware. He explained that both his assistants and himself were perfectly satisfied, by reason of the results obtained, that Transatlantic telegraphy was a possibility. He even hinted at a world-wide application. One thing he had noticed was that some of his messages were sent better and farther by night than by day, which had been explained by some as being caused by the diselectrification of conductors under the action of ultra-violet rays. He had also noticed that, under existing circumstances, it was not advisable to use self-restoring coherers at a greater distance than 900 miles.

INDIAN RAILWAYS.

DURING the official year to March 31st the length of new railway line completed in India was 459 miles, bringing the open mileage to 25,045. The new mileage is well under the average of recent years, for the reason that the famine necessitated a material curtailment of the Government's programme—the diversion of money allocated for railway construction to more urgent public works in the parts affected by the famine. Happily, conditions are mending. The trade returns for the twelvemonth show that the country, after the set-back of 1900, is again displaying its old elasticity and recuperative power. Imports increased by 519 lakhs of rupees and exports by 1695 lakhs. The improvement is reflected in better railway earnings. The gross receipts from all lines were nearly 253½ lakhs higher than those of the preceding year, though the new mileage was relatively insignificant. It is the North-Western State Railway which has mainly contributed to this splendid return, for the increased earnings on that system alone exceed 100¾ lakhs. Then comes the Great Indian Peninsula, with an improvement of nearly 55 lakhs; the East Indian running third with 33 lakhs. The big export of grain from the Punjaub through Karachi, and the revival of traffic on the Great Indian Peninsula system with Bombay as its port, were the features of the year. The grand total of gross earnings on all lines was close upon 34 crores of rupees, an enormous sum, on which the Government of India may well congratulate themselves. For the year 1902-3 the Secretary of State for India has sanctioned capital expenditure of 1050 lakhs of rupees (£7,000,000) to be almost equally divided between the provision of rolling stoke and other works in connection with existing lines on the one hand, and the prosecution of a construction programme on the other. Of the latter moiety, 350 lakhs will be absorbed by lines now in progress, and 174 lakhs by new railways. The line which is to reduce the distance between Allahabad and Faizabad will reduce the rail distance between the two cities from 235 to 98 miles, and will cost 117 lakhs, 40 of which are allotted for this current year. The East Indian grand chord is to be completed by filling in the gap of 112 miles from Gya to Katrasgarh, which is to cost in round figures two crores of rupees—£1,333,000—one-fourth of which sum is now sanctioned. The Bengal-Nagpur Railway is to be given access to the Palamow and Daltongunj coalfields by a line bridging the Damuda River, the preliminary amount allotted being 20 lakhs. In Western India sanction has been accorded to a scheme which has for some years been pressed on the notice of the Indian Government by the Bombay Chamber of Commerce—the Godhra Baroda chord. Forty-five miles in length, it will save nearly 30 miles in the through distance between places north and east of Godhra and south of Baroda, and obviate the delays to which the traffic of the Anand Godhra section of the Bombay, Baroda, and Central India Railway is subjected in the monsoon.

India, like the United Kingdom, has of late been subjected to much criticism on the score of light loads. In December last a Locomotive Conference sat in Calcutta with the principal object of altering and relaxing as far as might be advisable the regulations limiting the weight of rolling stock for work on the country's railways. It is complained that the constitution of the Conference was a mistake, in that it did not consist of "the experienced responsible heads of the railways who are the proper advisers on broad matters of policy, such as must govern the detailed treatment of the present issues." This is a point upon which an outsider can scarcely express an opinion, but the advance of India under the recommendations of the Conference will not be marked, and that the advance, even when shorn of the conditions attaching to its various heads, and proceeded with to the full, will leave India out of all comparison behind practice in America, and even in England, where the light loads carried by goods trains have recently been so much criticised. The weight of engines for each pair of wheels is to be raised from 15 tons to 19 tons; but this gain is largely discounted by the restriction of the average load per pair of wheels in the case of three or more adjacent axles to 15 tons, as before. The maximum load for each pair of wheels in the case of goods wagons is increased from 12 to 14 tons; but here, again, the advantage is partially lost by the weight per foot run, that is, in respect to length, remaining as before. Then there is the further limitation to the advances stated, that they cannot be made by locomotive superintendents and carriage and wagon superintendents in the ordinary course of business; but in every case where there is relaxation of the standard hitherto in force, a formal application must be prepared and submitted through the Government Inspector to the Government of India, accompanied by certificate by the technical adviser of the railway, desiring the sanction that all the girders and tracks over which the stock will be allowed to run are of sufficient strength for the purpose, and this certificate has to be accompanied by strain sheets and calculations in great number and variety. The wording of the recommendation of the Committee further shows that the application is likely to be questioned in the case of the older lines, where the bridges and tracks are lighter than now constructed. It is contended that, instead of half-hearted measures such as these, the experienced responsible heads of the leading Indian railways should first have determined the policy of the future in regard to advancement in the direction of increased train loads leading to lower freight charges, and that then the work of experts, such as formed the Locomotive Conference, should have come in to advise upon the best method of carrying out the policy decided on, in raising the standard of weights of locomotives and wagons, and where necessary, in strengthening the bridges and roads to bring them up to the increased standards.

COMBINED ENGINE AND DYNAMO.

WE illustrate this week a fine triple-expansion engine, by Robey and Co., Limited, Globe Works, Lincoln. The high-pressure cylinder is arranged tandem to the intermediate cylinder, as shown on page 613. The cylinders are 12½in. and 20in. and 35in. diameter, with a stroke of 42in., and capable of developing 900 indicated horse-power when running at 700ft. per minute, or 100 revolutions with a steam pressure of 180 lb. to 200 lb. per square inch. As will be seen from the engraving, the engine is of massive construction, large wearing parts and bearing surfaces, the bed plates being Robey and Co.'s "Mammoth" type, with facings to bolt directly to a base plate supplied for the generator, thus preserving the alignment of the shaft. The disc shaft is of steel, swelled in the centre for the armature and fly-wheel, the weights of which are designed to give a practically uniform angular velocity, the variation being under ½ percent.

The cylinders are each fitted with the firm's well-known automatic triple-expansion gear, specially designed for use with superheated steam, the temperature of which will be 460 deg. Fah. The speed of the engine is controlled by Richardson's spring governor, which allows a range of cut off from 0 to 50 per cent. of the stroke, maintaining the speed within 2 per cent. under all conditions of load. Special lubricating devices are fitted to the cylinders, quite automatic and positive in action; all bearings are supplied with oil by means of rotary oil pumps, the oil being returned to filter and reservoir. We give above a section through the high-pressure cylinder.

The workmanship is of the highest class, all brass work nickel-plated and finished off in the best possible manner. All parts are easy of access for examination and designed for continuous running. The dynamo is of the continuous-current type, multipolar, and compound wound for a potential of 230 volts, capable of absorbing the full power of the engine. The magnet frame is of cast steel, having twelve magnet poles bolted to it. The armature is of the drum-wound type, the winding being carried in slots milled in the armature core and carefully ventilated. The dynamo has been supplied by D. Selby Bigge and Co., electric power engineers, Newcastle-on-Tyne. The plant is to be used for electrically driving the works of Head, Wrightson and Co., Limited, Thornaby-on-Tees.

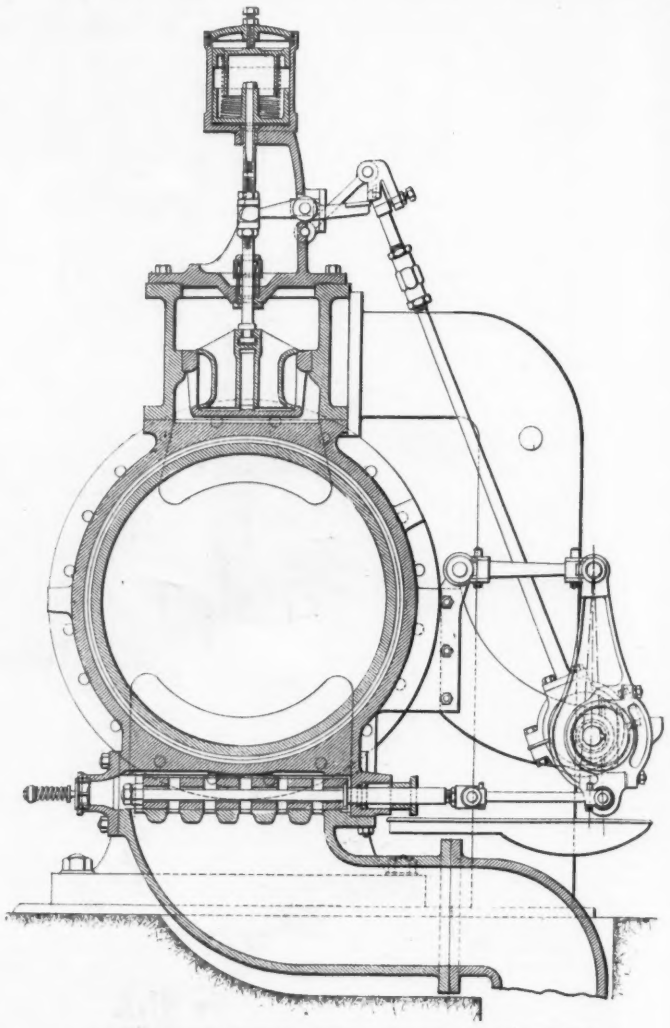
THE United States Patent-office had granted, up to January 1st last, 681 patents for the manufacture of ice machines.

THE ELECTRIC PROBLEM OF RAILWAYS.*

By J. SWINBURNE.

(*Concluded from page* 548)

Constant pressure direct.—At 60 kiloms. (37·5 miles) per hour the kinetic energy is 139 Joules per kilo.—38·5 ampère hours per ton. In the case of constant pressure series and parallel, the station has to supply 209 Joules, as the efficiency is 0·66. On braking, 0·66 by 139, equals 93, are returned to the system, making a loss of 116 Joules per kilo. With the series system there is no outside resistance loss, and in this hypothetical case the whole 139 Joules would be returned. The true position is that in each case the station has to provide the loss by resistance in the fields and armatures of the motors, the loss in any regulating resistances, the loss by train resistance, and the kinetic energy. These are all common to the two systems, except the loss in the regulating resistances. We may therefore estimate the saving in them by themselves. In the last case the loss is 116 Joules per kilo., and the distance is 0·75 kiloms.; so the loss is 155 Joules per kilogramme-kilometre. This saving looks enormous, but it must be remembered that we are working with a large acceleration and a high maximum velocity.



TRIPLE-EXPANSION ENGINE—SECTION THROUGH VALVE CHESTS

To make a better comparison, let us take the sample case again, and make it a little more practical. We may take the motors as having an efficiency of 85 per cent. at normal current when there is no resistance in series. We may take 7·5 per cent. lost in pressure, and 7·5 per cent. wasted mechanically. Let the sample train weigh 100 tonnes or 100,000 kilos. (98·5 tons) and let there be acceleration of 0·7 up to 60 k.p.h. in both cases. Assume the pressure on the constant pressure circuit is 1000 volts. Just at the point when 60 kilom. p.h. is reached, there is a pull of 7100 kilos. at a speed of 60 k.p.h. This represents a power of 1190 kilowatts. As the motors lose, on the assumption we have made, 7½ per cent. of their pressure by resistance, we have 925 volts available. The acceleration current is therefore 1285 ampères. The resistance of the train, apart from acceleration, will demand a pull which is a little uncertain as to amount. It will vary with the speed. It will probably vary from 0·1 to 0·4 per cent. of the weight of the train up to 60 k.h.p. Merely for simplicity of calculation we may take it as 0·25 throughout. This is the same for all, and it is only in a case of rough comparison that such a proceeding is permissible. As we have taken a sample train of 100 tonnes, the pull for train resistance is 250 kilos., needing at 60 k.p.h. 40·8 kilowatts, or 44·3 ampères at 925 volts. The total active current is therefore 1329 ampères, and the total current 1440 ampères, allowing the 7½ per cent. for non-electrical losses, and the total power taken by the motors 1440 kilowatts.

Let us now consider what happens during acceleration and stopping. For simplicity, we may assume one pair of motors only, each motor being wound for 720 ampères and 1000 volts, at 60 kiloms. p.h. On starting they are in series, and run up to 425 volts back pressure, that is to say, 27·6 kiloms. (17·25 miles) p.h. That the motors are switched into series a little earlier makes so little difference in the efficiency—about ¼ per cent.—that it may be neglected. Up to half speed 1000 volts and 720 ampères have been on for 10·4 seconds, making 7500 kilojoules. From change-over point to full speed is 13·4 seconds, at 1,000 volts and 1440 ampères, making 19,300 kilojoules, or 26,800 kilojoules (7·4 kilowatt hours) for starting. The train then has to run for 21 seconds without acceleration, with a drawbar pull of, say, 400 kilos. (808 lb.). This needs 71·5 ampères, and in 21 seconds uses up 1500 kilojoules. The total energy taken from the conductors is thus 27,300 kilojoules. It is not usual to brake with series motors, but by putting two motors in series with resistance, economical braking can be done between full and half speed. As the acceleration we are taking is higher than usual, and as there is more kinetic energy to be saved in such a case, it will be fairer as a comparison to

* Paper read at the ordinary general meeting, February 25th, of the Manchester Section of the Institution of Electrical Engineers.

suppose the series motors are used as dynamos. If the motors are in series, and the retardation is the same as the acceleration, the current will be less, as the train slows of itself.

Assuming the fields to remain the same, on braking there should be a back pull of 7100 kilos. The train resistance provides 250, so the motors should give a back pull of 6850 kilos. At 92·5 per cent. this corresponds with 568 ampères, the motors being in series. This goes on till the speed falls to 37·3 kiloms. p.h., taking 9·1 seconds, and giving out 5160 kilojoules. The return will really be a little less than this, as the motors acting as dynamos are unstable at the lower limit. The series motors thus take in 27,300 kilojoules, and return 5160, or 19 per cent. Shunt motors will give approximately the same results on constant potential. The armatures or fields need not be reversed for braking. The shunt motor has no real advantage in this case, and it has the disadvantage of possible commutator troubles, and of large variations of current. The resistances are altered by steps, and not continuously, and this causes a larger variation of current in a shunt motor, as the field resistance is not in series with the armatures, and there are no corresponding variations of field tending to check the variations of current.

Constant pressure three-phase.—The three-phase system is analogous to the shunt direct current. It has the advantage of absence of commutator. Compared with the series-wound direct current, this is of little importance, as there is no trouble from sparking. The motors have an idle current, however. This is really a question that concerns the distribution mainly; but it also concerns the motors during acceleration and braking. It lessens the brake-power. The idle current depends on the air-gap, and on the frequency. If the second motor has a power factor of 0·9, as the first will have to carry the idle current for the second, its power factor will be about 0·72. The first motor will thus have to be rather larger, but the power taken and returned by braking in concatenation will not be less than that in the case of the direct-current motors to such an extent as to make it worth while to work an example out. The power returned by concatenated motors braking is saddled with such a bad load factor that it is probably not worth having.

Constant current direct.—Take now the simple series direct-current motor on constant current. If the maximum terminal pressure at 60 kiloms. per hour is 1000 volts as before, the motors again take 1440 ampères. The pressure at starting is 75 volts; so the pressure rises uniformly from 75 to 1000, the average being thus 537·5. This, with 1440 ampères for 23·8 seconds, makes 18,600 kilojoules supplied by the line. The energy taken is therefore 18,600 kilojoules (52·5 watt hours per ton). The train then runs at constant speed for some seconds. As a matter of fact, it would really accelerate in practice. The motors would be in parallel, each taking half the current and giving about 250 volts back pressure. This corresponds approximately to a quarter of the normal acceleration. The fields may be weakened by shunting. In practice the motors would be thrown into parallel before 60 kiloms. per hour was reached, and there would be a saving. We may for comparison take the same figure as before, and allow 1500 kilojoules, so the energy supplied to the motor terminals taken is 20,100 kilojoules.

On slowing down the negative acceleration will be too rapid, as the 7·5 per cent. has to be taken the other way, and the train resistance is also stopping the train. To correct this it would be necessary to shunt the fields a little; but as in practice there is little objection to a slightly increased negative acceleration, especially if it is put on gradually, we may take the motors as they are. As the current is 1440 ampères, the negative acceleration is 0·875. This will pull the train up in 19 seconds, returning 1440 ampères at terminal pressure ranging from 850 to 75, or an average of 387·5 volts for 19 seconds. This amounts to 10,600 kilojoules. The total energy taken is therefore 18,600 kilojoules, of which 10,600 are returned, leaving a balance of 8000. The constant otential system used up 27,300, or about three times as much.

Constant current three-phase.—The three-phase system can also be worked on a constant-current circuit; but as the frequency must vary with the speed, each train must have its own engine, unless some special arrangement is made in the distributing system. One special arrangement will be brought forward in discussing the question of distribution.

Distribution on short lines.—Turning now to the question of distribution, the first point is to settle the pressure. The present practice of 500 volts is really due to the street tramway; there is no particular reason why it should be adopted for railways. It may be said that 1000 volts is dangerous, and 2000 to 5000 means practically certain death if a contact is made. Other things being equal, alternating pressures of the same volt-meter value are more dangerous than direct, and in making comparisons as to danger it might be best to allow the same maximum pressure in each case. This paper is meant rather to deal with the future, and it seems highly probable that as soon as there is a strong commercial necessity for dangerous pressures they will be allowed. There is always danger in connection with rapid locomotion, and people are not supposed to make a promenade of a railway track. If high pressures are to be used, they should be made as safe as possible, of course, by the best safety devices. Still, the danger is a drawback, and whether there are safety devices or not, a high-pressure line should be considered as dangerous, and people fully warned, so that if they court danger it is at their own risk.

In dealing with the short railway, 1000 volts has been taken as a convenient pressure, and there seems to be an impression that there is something about alternating and three-phase machines which gives them some sort of monopoly of high pressure. The reverse is largely the case as regards danger, and as regards insulation. As to the distribution in the various cases discussed, the current in the direct-current constant potential system is half for the first part of the acceleration, so there is some economy there compared with the series system. Roughly, the current for half the time of starting is only 720 ampères. It is 1440 for the other half, corresponding to an effective current of 1140 ampères. The three-phase takes 720 right through, but there is an idle current to be considered. During the first half the power factor was taken as 0·72, so the current is 1000, and during the second half it is 800, the factor being 0·9. This gives an effective current of, say, 890 ampères. The series system, however, demands the whole 1440, not only during acceleration, but during running, and during stoppages at stations. The question of how far series pays depends largely on the distance from the generating and sub-stations. If the distance is great, the constant potential direct-current can be modified by only using one motor during the second part of the acceleration. As already explained, this does not increase the time between stations much, and it reduces the current to 720 ampères.

If there is a sub-station every second station, and acurrent density of something like 150 ampères per square centimetre is adopted, the loss in conductors is not serious. In a tube railway the trains are very frequent, so a low-current density pays. In long distance work the problem is very different. In the sub-stations there is little difference. For the direct-current constant potential the distribution is generally by extra high-pressure three-phase, with transformers and rotaries. For direct-constant current the extra high pressure is also direct current. There is no work of this sort in this country at present. Unless there is some special reason for distributing power in this way, other systems are better, or are, at any rate, more familiar. There is no difficulty in generating extra high-pressure direct current, and it is done in Switzerland, where Messrs. Thury have made a speciality of it. There is little doubt the insulation is cheaper, and there are no capacity or self-induction troubles, no idle currents, and no triple switches and measuring instruments.

The three-phase system avoids the rotaries, which is an advantage. On the other hand, three wires are necessary, and this involves an extra contact. The rails are not well adapted for alternating currents. The low-power factor increases the leads, the transformers, and the generators.

The constant-current three-phase system demands a dynamotor for each section, which is a drawback. The primary is extra high-pressure direct-constant current, and the secondary is constant three-phase current. For short tube lines this system seems to have no advantage over the direct-constant current.

In the station the constant-current system, whether direct or three-phase, has the peculiarity that the engines always work at constant torque, but at varying speeds. The result is, that for a given daily output the coal consumption is less, as the engines always work at the best cut-off. The wear and tear is also probably somewhat less.

Long railways: Comparison of systems.—Instead of dealing next with an intermediate or suburban line, it may be best to go to the other extreme, and consider a main line. The problem is entirely different. Acceleration is comparatively unimportant, and the energy is chiefly used for overcoming the train resistances. The capital cost in mains and sub-stations is greater in proportion to the traffic, as large proportions are frequently idle. It is therefore important to run light trains frequently. The present system tends towards heavy trains run comparatively seldom, and in goods traffic this practice is carried as far as possible. It is therefore very difficult to decide on anything like a simple case of main-line traffic. In the first place high speed is advisable, more especially between such centres as London and Manchester, and Manchester and Newcastle. Such cases as inter-communication between Manchester and Liverpool, or between the various busy Yorkshire centres, belong to the intermediate class. It must be remembered that it is comparatively easy to devise systems, not only of block signalling, but of automatic control for electric railways, as the power is not generated on the train, and can therefore be shut off from the outside. We may therefore have lighter trains running at high speeds, and running frequently. As a sample, we may therefore adhere to the 100-tonne train. We may, having regard to the future demands, consider a speed of 125 kiloms. per hour (75 miles per hour). It is difficult to make the case definite enough for clear comparison between the possible systems. We may, therefore, first run over the peculiarities of each, and see how they affect the problem.

The constant-pressure system with direct currents has the drawback of waste of energy during acceleration; but if the trains go long journeys, that is no longer important. The chief difficulty is the limit of pressure possible. There seems to be an impression that direct-current motors can only be made for low pressures. As a matter of fact, they are mostly made for low pressures; but that is merely because there is no demand for high-pressure machines, except for arc lighting; and there is little series arc lighting now. As a direct-current machine can be easily made to give from 1000 to 2000 volts for arc lighting, there can be no difficulty in making large railway motors for such pressures. An arc machine is the most difficult to make for high pressures, because the rate of increase of the pressure relatively to the current has to be negative; so that the field is comparatively weak, and the diameter of commutation varies. If a 10-ampère machine can be made for from 1000 to 3000 volts, there can be no difficulty in making a similar machine for about 1000 ampères.

It may be safe to take 2000 volts as suitable for main-line work. The limit of 2000 volt transmission is not so small as may be thought. Our ideas of transmission distances are largely gathered from incandescent lamp practice. In that case there is an accumulation of small drops; in the high-pressure mains, the transformers, the meters, and the house leads; and at the end is a lamp which is sensitive to minute variations. In the case of a main-line train, we may lose quite a large percentage of the pressure in the mains. At a current density of 150 ampères per square centimetre the loss of pressure is 27·2 volts per kilometre. If we care to spend 500 volts on the mains between two points of supply, the points can be 37 kiloms. apart, if there is no loss in the return leads. It is unlikely that a main line could be run satisfactorily on the three-wire system, so instead of 37 kiloms. it would be better to allow little more than half that distance, say, 20 kiloms. This means a sub-station every 40 kiloms.

The direct constant-pressure system has the great disadvantage of only suiting fixed speeds. Thus, if the motors are wound for 120 kiloms. at 2000 volts, they will not work efficiently at any lower speed. The train, therefore, must run at 120 kiloms. per hour, or waste power. This trouble can be largely overcome by making the motors large, so as to give a better acceleration. Two motors in series will then run the train considerably above 60 kiloms. per hour. The two motors in parallel will also run the train above 120, so as to give some margin for making up time—a most important consideration.

The series-constant direct-current system has no longer the same advantages as in the case of the tube. The acceleration is no longer of vital consequence. With a given maximum pressure, and a given distance between sub-stations, the loss in the leads is greater, for the leads always carry the maximum current. The series system has some compensations, however. It does not follow that because the motors are taken as limited to 2000 volts, that the line may not work at, say, 10,000. The difficulty here is that the motor must be insulated from the bogie, so as to stand high pressures. 10,000 volts with a maximum loss of 25 per cent., or 2500 volts, would allow a distance of 92 kiloms. between sub-stations. This would generally mean that there would be no sub-stations, only generating stations, and they could be placed, as a rule, near large towns, so that they could supply their customers. The series system has the advantage of allowing any speed at high efficiency. The ability to return energy in braking need not be considered, as in long distance work it is impossible to allow large enough motors to give good acceleration. It would therefore pay better to brake by mechanical means than to waste time slowing down in order to get back a little energy.

The three-phase constant-potential system has some of the advantages of the constant-pressure direct current. It falls behind in some points. There are three wires instead of two, and the motors cannot exceed their normal speed, however late a train may be. On the other hand, the system has the advantage that it can be worked for long distances, as frequent sub-stations can be put down, as they contain only still machinery. The distances apart of the generating stations are thus only limited by the economy of transmission at high pressure.

The series three-phase system gives the same advantages as regards distance between central stations, but it is at a disadvantage compared with constant-pressure three-phase system, as its advantage in acceleration is more than compensated by the need of having sub-stations with moving machinery for each block, with a dynamotor for each train that may be fed by the sub-station.

Constant pressure direct.—For the sake of making some sort of comparison, we may take the generating stations as 80 kiloms. (50 miles) apart. This is certainly far enough to prevent the need of an excessive number of power stations. At the busiest time of day, which is what has to be provided for, we may take a half-hour service each way as sufficient for through traffic. This will demand stations of the order of 6000 to 8000 kilowatts, which is smaller than one likes, but still large enough to be fairly economical. Taking first the direct-current constant-pressure system at 2000 volts, the simplest arrangement would be to have two sub-stations for each power station. A train would then never be more than 13·3 kiloms. from a sub-station. The trains want, say, 330 ampères at full speed. A question at once comes up, whether it pays to have greater torque for accelerating. The simplest way of doing this is to have a double allowance of motors. At starting two motors are in series, and at half speed the extra motor is thrown out. As the motors will probably drive at least four axles, there will be, say, four motors of 1000 volts each, and they will all be in series on starting, only two being in series above half speed. The starting motors may be comparatively small, as they only run for a minute or two at a time, and are then cooling for the rest of the journey.

The conductors have to carry 330 ampères, which at 150 per square cm. means 2·2 square c.m. Strictly speaking, however, the lead should not be run at a constant density, for the current is in the parts near the sub-stations longer. We may take the lead at 1·5 square c.m. average area for each track. This would mean 1·5 by 2·92, equals 1·338 tonnes of copper per kilom. for the main. It is a question how much should be allowed for the return, as it would naturally be worked on the three-wire system; but sometimes one side might be full and the other empty, so it might be as well to allow, say, 14 tonnes of copper for the return of which seven would be charged to each side, making 24 tonnes. At £70 per ton this means £1680 a kilom. for copper, or £3360 per kilom. of double track.

Each transformer sub-station must supply one-third of the distance between the main stations; that is to say, 27 kiloms. Each ought to be able to supply 1·5 times the power for a single train; that is to say, 2000 volts and, say, 1000 ampères. This would be effected by one large rotary with another as spare, or by two 1000 kilowatts rotaries with one spare. Then the transformer sub-stations would have 27 kiloms. of high-pressure cable at, say, 8000 volts and 250 ampères. For the constant potential system at 2000 volts we may reckon for each distance of 80 kiloms.

Distributing mains (copper only)	—	25,000
9000 kilowatts static transformers	11,250	11,250
6000 kilowatts rotary transformers	18,000	18,000
Extra high-pressure mains	80,000	53,000
Total		94,750

The figures only refer to the parts that vary with the system adopted, and therefore do not give the cost of fitting out the railway electrically. They are also very rough estimates.

Constant current direct.—The series system has two mains for each line, carrying 330 ampères, 1·5 sq. c.m. in section. This comes to 6 by 8·92, equals 5·35 tonnes per kilom., or £30,000 per section, bare. A large addition would be necessary for insulating for 10,000 volts.

Three-phase.—The three-phase system is the same as the direct-current constant pressure, except that there are no rotary transformers. In this case it might pay to have more sub-stations, so as to decrease the cost of the copper, as the cost of sub-division of sub-stations would not be serious. The constant-current three-phase system saves some £10,000 per section in transformers, but costs extra for extra sub-station rotaries. The result of these estimates is that series costs less per kilom., but the comparison is by no means on all fours, as the constant pressure has high-pressure cables completely protected from contact, while the series has 10,000 volt conductors exposed, involving danger and cost of maintenance. It is, perhaps, hardly necessary to work out a sample of intermediate types, such as between Manchester and Liverpool, because they are equivalent to sections of the through main line. The only difference to be considered is the question of frequent stoppings and startings. A main line runs quick passenger trains, also stopping trains, goods and minerals. At present a slow and a stopping train are synonymous. There is no reason why a train that stops at many stations should run slowly between them, except that a locomotive that is designed for acceleration is not suitable for running fast, though the steam locomotive is better than the electric on constant pressure, because it is not wasteful while accelerating. It is just as important that stopping trains should waste little time, as that expresses should be fast; in fact there is greater reason in many cases, as the worst and most uncomfortable carriages are put on these trains. The most important are the suburban trains, carrying large numbers of business men, and stopping at nearly every station. In this case acceleration is of the highest importance, as in the tube railways.

Conclusion.—Enough has now been said to show that it is advisable to pause a little before we convert our railways into electric street tramways. We may, by doing so, not only work under drawbacks, which, though unavoidable in tramways, need not exist on railways; but we may stereotype a system which is found to be more and more unsuitable as the "electrification" of railways develops. It is most important that systems should not be adopted which prevent coupling up with other systems. There is a rapid growth of tubes in London at present. Each is treated as an independent railway now, but some day there may be a great need to couple various tubes on to suburban, and even main lines. In England our gauge is already too narrow and our height too little. It is perhaps outside the scope of this paper to point to the evils of running still smaller railways in tubes. It will be an unfortunate calamity if our railways take up different systems of electric working. If some have 500 volts, others 1000, 2000, or 10,000; if some have constant currents, some direct, and some three-phase, while others have constant pressure of each kind. There is some slight adaptability in electric locomotives. Of course, a three-phase motor will not run on a direct current circuit, but a constant-pressure locomotive will with very little addition be capable of running on a constant-current circuit; and locomotives can be built to run on either, if the pressures and currents are right. The locomotives built for 500 volts are not suitable for 2000 volts. If the 500 volt locomotives are for tube railways, with large acceleration, they can hardly be run as express locomotives, as their motors will run too fast; otherwise electric locomotives are more adaptable than steam, as they can have several motors, which can be coupled in different ways. What is most necessary is standard pressures and currents. Each railway would then have, as at present, slow locomotives with great pull for shunting, for goods traffic, and for suburban and stopping trains, and fast locomotives with less acceleration, but higher speeds for through traffic.

BOOKS RECEIVED.

Great Britain: Her Finance and Commerce. Souvenir edition of the *Morning Post*. For gratuitous distribution through the British Consuls, exchanges, principal hotels, steamship companies, &c., in all parts of the world. London: Published by the *Morning Post*. 1901.

Practical Spanish: A Grammar of the Spanish Language, with Exercises, Materials for Conversation, and Vocabularies. By Fernando de Arteaga y Pereira. Part I.: Nouns, adjectives, pronouns, exercises. Part II.: Verbs, &c., with copious vocabularies. London: John Murray. 1902. Price 7s. 6d. the two parts.

Guide to the Great Siberian Railway. Published by the Ministry of Ways of Communication. Edited by A. I. Dmitriev-Mámonov and A. F. Zdziárski, railway engineer. English translation by Miss L. Kúkol-Yasnapólsky. Revised by John Marshall. With two phototypes, 360 photogravures, four maps of Siberia, and three plans of towns. London: Edward Stanford. St. Petersburg: Typography of the Artistic Printing Society, English Prospect, 28.

COLLIERY WINDING ENGINES.—There has just been sent out from the works of Andrew Barclay, Sons and Co., Limited, Kilmarnock, a fine set of winding engines for the Cadeby Colliery of the Denaby and Cadeby Main Colliery Company, near Rotherham. The engines have probably a larger drum shaft than any in the kingdom, being 26in. diameter in the middle, and 20in. diameter in the journals, which are 3ft. long. The drum, which is being made elsewhere, will be 34ft. diameter, and all of wrought steel, and grooved for the rope, its weight approaching 100 tons. The cylinders are 45in. diameter by 7ft. stroke, and are fitted with Lancaster piston rings. The engine packings are floating packings, a speciality of the Combination Company, Gateshead-on-Tyne. The cylinders are fitted with Cornish valves and "Barclay's gear," with quick-acting patented exhaust cams, which give prompt exhaust and hold the valves full open till late in the stroke. There is a neat steam reversing gear, and a steam brake arrangement acting upon the Burns brake—that is, a single lever and single brake block lifted against the inside of the drum—the steam arrangements being such that if the steam fails the brake is automatically applied.

A WATER DYNAMOMETER.

THIS machine, which is illustrated below, was originally designed by the late Mr. William Froude for use in his experiments on the propulsion of ships, but has since been largely modified for use with stationary engines, and is claimed to be the machine best adapted and most trustworthy for superseding the old type brake band for testing the brake horse-power of steam engines and motors. An earlier form of hydraulic brake took the shape of an ordinary centrifugal pump, the resistance to rotation being varied to some extent by a valve placed in the outlet pipe. But to measure large powers, say 500 to 1000 horse-power, the apparatus would have become very cumbrous, and the range through which the power absorbed could be regulated would be insufficient. To meet these difficulties Mr. William Froude invented a new form of rotator and case, which gave a vastly increased resistance for given over-all dimensions, and also provided

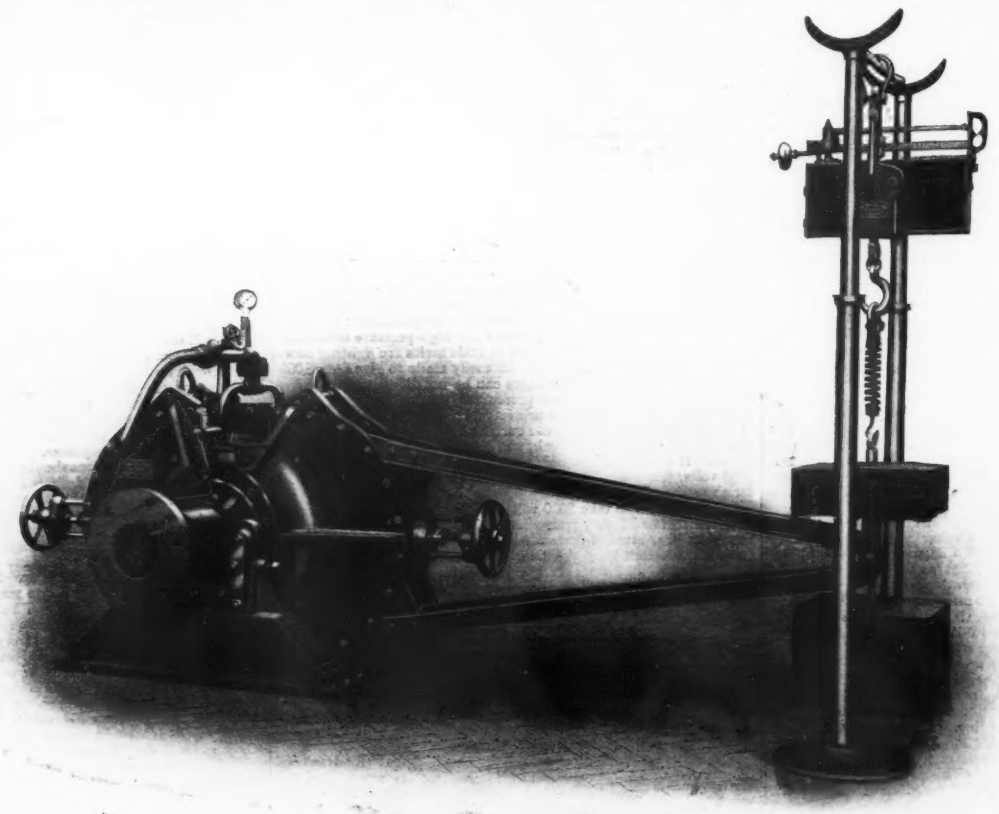


Fig. 1—THE FROUDE DYNAMOMETER

means for regulating the resistance through a very considerable range. The general arrangement of this machine is shown in Fig. 1. It consists of a case, or shell, within which revolves the wheel, or rotator. The latter is a circular disc, and on each side is formed a circular channel of semi-elliptical cross section. These channels are placed back to back, and are provided with a number of vanes fixed obliquely, as shown in cross section in Fig. 3. On each side of the

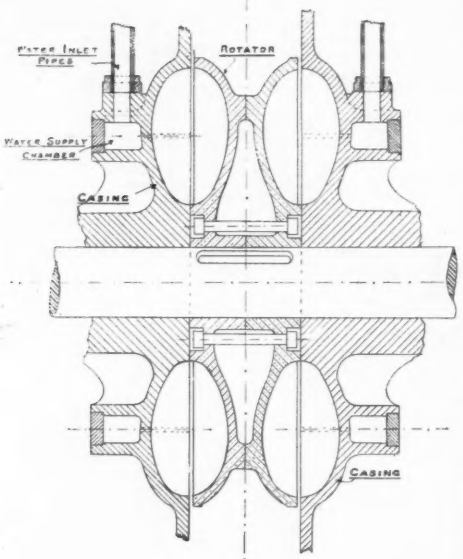


Fig. 2—GENERAL SECTION

casing similar channels are fixed, and also provided with vanes, thus forming two complete circular channels of elliptical cross section—see Fig. 2—the channels being divided into a number of complete compartments by means of oblique vanes. The apparatus being completely filled with water, and the rotator set in motion, the water contained in the cups of the rotator, under the action of centrifugal force, is delivered from their outer surface, and thrown with considerable force against the upper part of the fixed cups in the casing. The water then circulates round the outer surface of the fixed cups, and enters the bottom edge of the moving cups with an increased velocity, due partly to the velocity of its delivery from the fixed cups, and partly to the velocity with which the cups of the rotator meet the jet as it is delivered from the fixed cups. Thus a whirlpool or vortex motion is set up in each cup, the power required to drive the rotator being mainly expended in keeping this going. The whole of the power exerted being converted by friction into heat, in order to keep the machine cool, it is necessary to introduce a continual supply of cold water. In doing this it is essential that the whirling motion should not be disturbed, so the water is conducted through holes up the fixed vanes to points lying in the centre of the vortex where the pressure and velocity are low, and the circulation water being under a pressure of 15 lb. to 20 lb. per square inch, lodgment of air at this place is prevented. The inlet pipe for cold water is connected to a circular supply channel at the back of each set of fixed vanes, whilst the hot water is continually escaping into the outer part of the case and leaves by the outlet pipe shown, which, being at the highest point of the case, assists the escape of air or steam. The connections of these pipes are flexible, so as not to affect the balance of the machine. Cocks are also provided to permit any air collected to escape. It is interesting to note that the total power absorbed may be considerably increased by making the interior surfaces of the cups as smooth as possible, so as to admit of very high velocities of circulation in the individual cups. The power absorbed by the dynamometer is reduced when required by interposing a thin metallic shield between the faces of the rotator and casing, thus cutting off what may be termed the vortex action. In this manner the power may be reduced from the maximum down to about one-fourteenth of that amount. It will be noticed that the weight of the casing is not supported by the shaft, but carried by means of friction rollers. The rollers are provided with a slight adjustment, so that the shaft may be readily brought into line with that

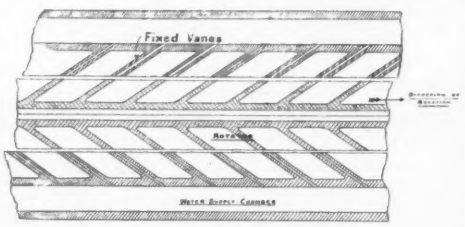


Fig. 3—CROSS SECTION OF VANES

of the engine or motor shaft required to be tested. The revolving rotator necessarily re-acts on the case, tending to carry it round with it, the turning moment being equal to that exerted on the driving shaft. The case, being carried on the rollers mentioned, is prevented from turning by a weighted lever, as shown in Fig. 1. It is found convenient to secure steady readings to provide a greater weight than actually required, the portion not supported by the brake being carried by a Dension balance, as shown. The effective weight is, of course, the total weight minus the reading of the balance. For instance, suppose the effective weight supported is W lbs., at 5ft. 3in. radius, and the revolutions are N per minute. Now, 5ft. 3in. radius corresponds to a circle of 16·5ft. circumference, hence the formulæ for the

$$\text{Brake horse-power} = \frac{W \times 16{\cdot}5 \times N}{33{,}000} = \frac{W \times N}{2000}$$

In using the machine the rotator shaft is first brought into line with the engine or motor to be tested and is coupled up. Water is admitted by the inlet pipe, the outlet being opened for the escape of air. As soon as running is commenced the water inlet should be opened full, the flow of water being regulated by the outlet, so that the outflowing does not attain too high a temperature, and a certain amount of pressure is thus maintained in the casing.

The machine is made in a number of standard sizes, and the differences between the various powers are obtained by the regulation of the shields mentioned above, which are moved by the hand wheels at each end of the machine. The maximum power which the machine will absorb varies as the square of the speed; thus, if a given dynamometer takes 100 horse-power to drive it at 100 revolutions, it will take 400 horse-power to drive it at 200 revolutions.

The water is prevented from passing out between the casing and the main shaft by the use of ordinary glands and packing, but it will easily be seen that no error is made by their friction, as this re-acts on the case in the same direction as the water. It may be interesting to note further that the range of temperature from inlet to outlet and the quantity of water used afford an accurate measure of the power, and the most recent determination of Joule's mechanical equivalent of heat was made by means of a Froude water dynamometer by Professor O. Reynolds and Mr. Morley.

The advantages claimed for this dynamometer for high-speed engines and motor testing may be summed up as follows:—That (1) it is suitable for use at highest speeds and for very large powers; (2) it is capable of regulation to any power within its limits without adjustment of weights; (3) it is simple to work, and cannot easily get out of order; (4) it is portable, and requires practically no foundations; (5) it is absolutely correct in its results.

This machine is, we are told, fast being recognised as the standard for brake horse-power tests, and has been supplied to most of the leading engine and electric motor builders in this country. The makers are Heenan and Froude, of Aston Ironworks, Birmingham, who exhibit it at Wolverhampton.

THE RAILWAY CLUB.—The June meeting of the Railway Club was held on the 12th inst. at the Memorial Hall, Farringdon-street, E.C., Mr. J. H. Cramp in the chair, and was the occasion of Mr. H. L. Hopwood reading a paper on the subject of "Lancashire and Yorkshire Locomotives, Past and Present," the development of which was ably discussed by the author, who illustrated his lecture with numerous photographs, scale, and working drawings. On the 21st inst. members will visit the locomotive department of the South-Eastern and Chatham Railway at Longhedge. Meet Queen's-road Station, London and South-Western Railway, 2.45 precisely.

COMPETITION FOR THE "GALILEO FERARIS AWARD."—The Committee for the "Galileo Feraris Award"—which was instituted in 1898, being composed of the representatives of the Executive Committee for the General Italian Exhibition, held in Turin in 1898, of the Chamber of Arts and Commerce, of the Royal Academy of Science, and of the Royal Industrial Museum in Turin—have determined to open an international competition for the award of this prize on the occasion of the unveiling of the monument to that illustrious scientist in Turin in the latter half of the month of September next. The award is of 15,000 Italian lires (£600), together with the compound interest thereof accumulated since the year 1899 up to the day of the award, and it shall be granted to the inventor of some practical application of electricity from which some noteworthy progress may arise. Competitors may produce either pamphlets, schemes, and drawings, or machines, apparatus, and contrivances concerning their invention. The jury, composed of the aforesaid committee, shall have full power to cause practical experiments to be made upon the inventions entered for competition, and upon the relative apparatus, contrivances, and machines. Competitors are to file their application and deliver their works, machines, apparatus, and whatever appertains to their invention not later than 6 o'clock p.m. on the 15th September, 1902, at the office of the Secretary of the Committee, care of the Administrative Committee of the First International Exhibition of Modern Decorative Art, in the buildings of the Chamber of Commerce and Art, 28, Via Ospedale, Turin, Italy.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

THE tone has considerably improved since the declaration of peace, and preparations are going forward at many of the works to meet the greatly increased demand which it is believed will sooner or later be experienced from South Africa, and which, indeed, is already setting in. The Indian railways are reported to be providing a fair amount of work. A steady demand for marked bars continues, and more orders for common bars are also reported. Prices continue unchanged at £8 10s. for marked bars; £9 2s. 6d. Earl Dudley's brand; second grade, £7 10s., and common unmarked bars £6 7s. 6d. to £6 10s., with North Staffordshire bars £6 10s. to £6 15s., and angles £7 5s. to £7 10s. Black sheets are in fair demand at from £7 15s. to £8 for singles; £7 17s. 6d. to £8 2s. 6d. doubles, and £8 10s. to £8 15s. trebles, with galvanised corrugated sheets £11 10s. to £11 15s. f.o.b. Liverpool. Gas strip makers are well occupied, and the recent advance of gas strip is well maintained. Hoop iron is quoted £7 5s. to £7 10s.; nail rod and rivet iron, £7 5s. to £7 10s., and gas strip £7. It is an evidence of the improved state of affairs that John Lysaght, Limited, have set in another rolling mill which has been idle for a year past.

In the steel trade there is a distinctly better demand for structural sections, chiefly, it is stated, for home consumption; export business also is fairly satisfactory. Quotations on the week have undergone little change. Bessemer billets are £5 to £5 5s.; mild steel bars, £6 10s. to £7; girders, £6 to £6 5s.; steel plates, £6 10s. to £7 10s.; and steel angles, £5 15s. to £6 5s.

Pig iron on the week is stronger in comparison with finished iron rates, it having gone up in some cases by from 6d. to 1s., and Staffordshire cinder forge has advanced about 1s. 3d. within the last week or so. Standard quotations are as follows:—Staffordshire cinder, 50s.; part mine, 53s. 6d. to 55s.; all mine, 57s. 6d. to 62s. 6d.; best ditto, 77s. 6d. to 80s.; cold blast, 95s. to 100s. Midland pigs are also firmer, Northamptonshires being quoted 51s. 6d. to 52s. 6d.; Derbyshire, 53s. to 54s.; Lincolnshire, 53s. 7d.; and North Staffordshire, 54s. to 55s.

At the South Staffordshire Mines Drainage Offices, Dudley, on Wednesday, a meeting of arbitrators and commissioners was held to hear appeals against a mines drainage rate for the Tipton district of 9d. per ton on coal and slack, and 3d. per ton on fireclay and limestone. There were present Messrs. J. R. V. Marchant, George Lewis, and E. Terry, arbitrators; and Colonel Cochrane, Messrs. Rowland Hill, Henry Perry, and Alfred Homfray, commissioners. Mr. H. K. Beale, on behalf of the Patent Shaft and Axletree Company, applied for an abatement of the rate on Crookhay, Millfields, and Millpool Collieries, which he said were situated in a pound, and did not derive any benefit from the commissioners' pumps. They had been rated under an agreement at 3d, but in 1900 they were raised to 4½d. Last year they were rated at 3½d., but in the draft award of a month ago they were assessed at 4d. He asked for a reduction of at least ½d. per ton. The meeting declined to make any change. Lodge Hole Colliery were put at 4½d per ton; Messrs. Cole, Bunker's Hill, at 5d.; Pendlebury Colliery Company at 6½d.; Messrs. Davies and Griffiths, Churchill Colliery, 6½d.; and Messrs. Sanders and Davies, Goldicroft, 6½d. In other cases no changes were made. The policy of the arbitrators was—with the above graduations—confirmed of raising the rate all round by ½d. per ton in order to keep the commissioners' pumps in operation. The South Staffordshire and East Worcestershire Coal Trade Wages Board have this week decided upon a reduction of 10 per cent., to take effect on the 18th of July.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—The unsatisfactory feature of the iron and steel trades in this district is the continued absence of any real life in the market. There is a fairly large volume of consumption going on, and a steady business passing through, with a general firmness in current rates, the tendency being upwards in some cases. A lack of confidence, however, prevails as to the future, and it is difficult to gauge at all accurately the real position. For most brands of pig iron quotations have been stiffening during the past week, advances of 6d. to 1s. having been put on in some instances. On the other hand, very low-cut figures have been quoted to effect sales of any weight, and there are merchants who are prepared to quote forward at under present rates. With regard to manufactured material, both iron and steel, although most makers are well sold they are unable to secure new business at better prices, notwithstanding there are complaints they are scarcely covering cost of production. German competition in billets, girders, and other material is coming to the front, and during the past week representatives of German houses have been offering in Manchester to sell at considerably under local prices. Altogether the situation remains one of uncertainty as to the future, and opinions vary so widely as to the possible course of the market that consumers have no confidence to buy beyond actual requirements.

A fair amount of inquiry was reported on Tuesday's Manchester 'Change meeting, and in pig iron a moderate business was being put through, with quotations advanced for both Lincolnshire and Scotch brands. Lincolnshire makers, at a meeting last Friday, decided upon an all-round advance of 6d. per ton on their official minimum basis. In view of the fact that practically with one exception makers are oversold, and considerably in arrear with deliveries, it was anticipated No. 3 foundry, which a month or so back was unexpectedly reduced 6d., would be put up quite 1s. per ton, and the small extent of the advance has been a surprise. Lancashire makers have followed the upward move to some extent. Derbyshire brands, which are scarce, remain nominally without quotable change. Delivered Manchester, No. 3 foundry qualities are quoted 58s. 6d., less 2½ Lancashire, and 56s. 6d. to 58s. Derbyshire, and 53s. to 53s. 6d. net Lincolnshire; with forge qualities, delivered Warrington, about 54s., less 2½ Lancashire; and 52s. 8d. net Lincolnshire.

Middlesbrough is perhaps scarcely so strong, and in some quarters it is believed prices will have to come lower. Average quotations remain, however, about 57s. 10d. to 58s. 4d. net by rail Manchester. Scotch iron, moderate sales of which have been made recently in this district at low-cut figures, have been stiffening, quotations in some cases having been raised 6d. to 1s. per ton, as the result, it is stated, of recent purchases on American account. Eglinton averages 57s. 6d. to 58s., with Glengarnock quoted 61s. 6d. to 62s. net delivered Manchester docks.

Finished iron makers' books are tolerably well filled, but there is an absence of any pressure of requirements, and notwithstanding the stiffening in pig iron their quotations have to remain at recent rates, averaging £6 10s. Lancashire, and £6 10s. to £6 15s. North Staffordshire bars, £8 5s. to £8 7s. 6d. sheets, and £7 2s. 6d. random, to £7 7s. 6d. special cut lengths of hoops, delivered here, and 2s. 6d. less for shipment. Some makers, however, are showing a disinclination to book forward in any quantity at these figures.

Prices in the steel trade generally are without quotable change. Hematites are perhaps a shade easier, No. 3 foundry ranging, according to brand, from 68s. up to 69s. and 69s. 6d. net, delivered Manchester. Local-made billets remain £4 18s. 9d. Warrington, and £5 Manchester, net. Steel bars in special cases have been advanced to £6 15s., but this figure is out of the market, £6 10s. to £6 12s. 6d. remaining the actual basis where sales are made. Common plates still average about £6 2s. 6d. to £6 5s., and boiler plates £7 10s., less 2½, delivered in the Manchester district.

In the engineering trades the slight tendency towards some improvement noted last week would seem to be maintained, although it scarcely represents any very material change in the position generally. Amongst machine toolmakers more inquiries are stirring, chiefly in connection with Government work, and most establishments have orders sufficient to keep them moderately employed. Boilermakers have still plenty of work in hand, and the locomotive building and electrical engineering trades continue pressed with orders. There is also a good deal of work stirring for bridge-building and other structural operations. The textile machine trades remain the most unsatisfactory branch of engineering, no appreciable indications of reviving activity being noticeable in this department.

The employment returns of the trade unions are in some directions of a more favourable character. Although the Amalgamated Society of Engineers has to record an increase in the total number of unemployed members as a result of the Dublin strike, the proportion being now about 3⅞ per cent., they are able to report a somewhat brighter outlook in this immediate district. The organising delegate states that there is a call for pattern-makers, which is a good omen. "At the present time," he adds, "there are no men of that craft signing our vacant book, and consequently there is some difficulty in meeting the demand. It is to be hoped that this is the forerunner of other branches of the trade being better employed in the near future." The Steam Engine Makers' Society has 2 per cent. of the total membership on donation, but only 1 per cent. locally. In the United Machine Workers' Association a material reduction has taken place in the out-of-work list, although this is still abnormal, representing 5 per cent. throughout the country, and about 4 per cent. in this immediate district.

At the half-yearly meeting of the Manchester Association of Engineers held on Saturday the following new members were elected:—Messrs. Alfred Cotton (Meldrum Bros., Manchester), John Davidson (Browett, Lindley and Co., Limited, Patricroft), Alfred Evans (Royles Limited, Irlam), J. S. Heriot (Manchester), H. N. Leask (Heenan and Froude, Manchester), and C. E. Stromeyer (Manchester Steam Users' Association). Messrs. Daniel Adamson, George Kiernan, R. Matthews, W. Taylor, and Arthur Walsh were elected members of Council.

The Council of the Association has issued a special circular to members with reference to the preparation of an international technical dictionary, to be called the "Technolexicon," which has been undertaken by the Society of German Engineers. This society, it is stated, invites the co-operation of engineers in this country who are able to supply the technical expressions used in the different branches of engineering, so that a dictionary may be compiled which will be of real use, and the Council of the Association requests members willing to assist in the work as collaborators to send in their names to the secretary, who will transmit them to the compilers of the "Technolexicon." The dictionary will be published in three volumes, as follows:—Vol. 1—German, English, French. Vol. 2—English, German, French. Vol. 3—French German, English.

Simpson and Bibby, of Manchester, are just completing for a gold mining company in West Africa a specially-designed steam lurry, to carry about 10 tons. The lurry will be used for conveying machinery and provisions from the coast to the mines, and is particularly adapted for passing through the jungle. Soft wood will be employed as fuel for steam-raising, this being carried in an iron framework at the back, and the combustion spaces in the boiler are so arranged as to give the most effective results with this class of fuel. The weight of the lurry, &c., apart from the load, is 8 or 9 tons, and the engine is of 100 horse-power. The firm has in hand for the Transvaal a steam lurry, burning coal as fuel, to carry about 7 tons, the engine being 50 horse-power.

In the course of a discussion on mine ventilation at a meeting of the Manchester Geological Society, Mr. J. Gerrard, H.M. Inspector of Mines, observed that he could scarcely understand how any one could waste a shaft by allowing it to act as a chimney for furnace ventilation, when by mechanical ventilation they could get a large amount of benefit from the shaft. As to economy, there was much to be said in favour of mechanical as against furnace ventilation, and he could not understand anyone putting down a furnace now-a-days.

Discussion also took place on the paper dealing with the national interest in the coal supply read by Mr. W. Pickstone at a previous meeting, in which he advocated that the State should take possession of all coal deposits that had no present commercial value by reason of the depth at which they lay, and should take steps by boring to ascertain what coalfields we had. Mr. J. Dickinson remarked that it was not a new thing that Government should hold mining property, as many royalties were already held by the Crown. The endeavour to unite properties suitable for large mining operations was good. If effected, suitable areas could be had for expensive deep winnings, and many needless barriers would be avoided, also objectionable way-leaves, and the cost of pumping water apportioned. Professor Boyd Dawkins scarcely saw how such control as was suggested by Mr. Pickstone could be brought about without interference with the rights of private property, and though he sympathised with the main idea he did not see how it was possible to carry it out under present conditions. Mr. James Tonge thought the matter should be taken up in some way, and Mr. L. B. Wells also agreed with Mr. Pickstone's main principle, though he could not say how it was to be carried out.

In the coal trade, although it can scarcely be said there is any real pressure of demand, requirements for nearly all descriptions of fuel are keeping up fairly well with the present output, and nothing of any moment is accumulating at the pits in stock. The reduction in wages is not unlikely to be made the basis by buyers for seeking some corresponding concession in prices. It is, however, very questionable whether there will be any further official reduction, the relief which colliery owners have obtained in the matter of wages being not more than compensation for the lower prices that have already been conceded. Possibly with a spell of hot weather during June there might have been some giving way in prices with the commencement of July, but apart from some slight easing here and there under special conditions any general downward move would seem now to be out of the question. Such surplus as collieries accumulate will be required for winter stocking purposes, and any pressing necessity for reduced prices through excess of production which would at the same time at all endanger wages, would no doubt be met by a general restriction of the get.

For house-fire consumption the altogether exceptional coolness of the season has kept up a much larger demand than is usual at this time of the year, the result of which is that the better qualities of round coal are still meeting with a tolerably ready sale, and maintaining their price.

The lower descriptions of round coal continue in very fair inland request for steam and forge purposes, and prices are being steadily maintained at about late rates, 8s. 6d. to 9s. being average figures for good ordinary descriptions at the pit.

For all the better qualities of engine fuel there is a tolerably active inquiry, and it would seem likely that the large requirements in connection with the numerous electric power stations that are coming into operation throughout this and other districts may very materially strengthen the position as regards good sorts of slack suitable for steam-raising purposes. Already there are large extra inquiries on the market for slack suitable for the above requirements, in addition to the usual demand for general steam consumption in the district, and the tendency of prices is in a hardening direction, although there is, perhaps, not as yet any really quotable change on late rates. The better qualities of slack are very firm at 6s. 6d. to 7s., with good washed slack fetching 8s. at the pit. The large surplus output of slack in outside districts, chiefly Derbyshire, still tends to keep down the prices of the commoner sorts of Lancashire slack, which might be bought at 4s. 6d. for very inferior descriptions up to 5s., with medium slack to be bought without difficulty at the pit mouth in the Derbyshire district at about 2s. 6d. to 3s. per ton.

Only an indifferent sort of business is reported in the shipping trade, with prices ruling low for steam coal, common sorts being obtainable about 9s. 6d. to 9s. 9d., ordinary qualities about 10s., and better descriptions 10s. 3d., delivered Mersey ports.

Coke continues in active request, with prices very firm at full rates, and a tendency to stiffen in quotations for forward contracts, this applying both to Lancashire and Yorkshire cokes used for iron-making purposes.

Barrow.—There is a good trade doing in hematite pig iron, and the market shows great steadiness, makers for the most part being heavily sold forward. There is a very large demand for mixed Bessemer numbers, but only a small trade in inferior sorts. Of the latter only a very small tonnage is made. Prices show practically no variation. Mixed Bessemer numbers are quoted at 60s. 6d. per ton net f.o.b., the price at which they have stood for several months past. Warrant iron sellers quote 60s. 1½d. net cash, buyers 60s. The stocks of warrant iron on hand have not changed during the week, 13,907 tons being still at hand, and no transactions of any sort took place. The stocks, which stand at a very low point, are very firmly held. There are still 36 furnaces in blast—one being on spiegeleisen—compared with 35 in the corresponding week of last year. One of the furnaces at the Millom Ironworks last week produced a record output so far as this district is concerned—1365 tons. It is not one of the American type of furnaces which have been built at Askam and at Carnforth, and which are expected to produce 2000 tons per week, but higher temperatures and heavier blast is becoming the practice in the district, and a fuller output is the result.

The trade in iron ore is very brisk, and there is a good inquiry for best sorts, but heavy parcels of Spanish ore are required to maintain the furnaces in blast. Prices show no change, native ores being at 12s. net at mines, and best descriptions at 16s. Spanish ores are still at 15s. per ton, delivered at West Coast ports.

Steel makers are very busy, and there is especial activity in the steel rail trade, orders being very largely held on home, colonial, and foreign account, while the requirements from all quarters are on the increase. Prices remain easy. More activity is noticeable in the Siemens-Martin's department, and orders for ship and boiler plates are plentiful, the prospects for the year being decidedly good, and especially so as greater activity is anticipated in the shipbuilding trade. Hoops are steady, and there is a full demand for tin bars, slabs, and billets.

Shipbuilders are briskly employed, chiefly on important Admiralty contracts.

The export shipping trade continues to be well employed. During last week the shipments of iron represented 10,811 tons and steel 11,550 tons, as compared with 3737 tons of iron and 10,426 tons of steel, an increase in iron of 7074 tons and in steel an increase of 1124 tons. The shipments this year stand at 189,918 tons of iron and 247,818 tons of steel, as compared with 157,951 tons of iron and 210,224 tons of steel, an increase in iron of 31,967 tons and in steel an increase of 37,594 tons.

Coal and coke shows no improvement, and prices are weak.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THE South Yorkshire coal trade is at present exceptionally busy, the weight of coal brought to bank being far above the average. The reasons are not far to seek. Holidays have been rather abundant of late, and the miners' demonstration at Rotherham this week has also tended to restrict the output, while the Coronation festivities which are close at hand will have to be provided for in advance. In house coal the best classes are most in demand, and with the weather continuing raw and unseasonable—up to the 17th inst.—fires have been as frequent as they were in mid-winter. A heavier demand is reported from London, where agents are ordering more freely in order to carry them over the Coronation. Under these circumstances, of course, prices are firm. Best Silkstones readily fetch up to 13s. 6d. per ton, Barnsley house maintaining its former value at 11s. 6d. to 12s. per ton; seconds and nuts from 10s. per ton.

In steam coal larger tonnages are being delivered to the various railway companies, while the shipping demand is also better. Values, however, continue as before, the contract rate of 8s. 9d. per ton being exceeded in the open market by from 6d. to 1s. per ton. Good slack and engine fuel are also in improved request. Commoner qualities, however, are not called for, and can be had at very low rates. Slack fetches up to 5s. 6d. and 6s. per ton, these qualities being wanted chiefly for coking purposes. Other sorts do not make more than 3s. 6d. per ton.

The season for large consumers of coal, more particularly railway companies and gas companies, arranging their contracts, has again arrived. The gas companies have in some instances already concluded their negotiations, with the result that they have been able to provide themselves for the next six months at 6d. to 1s. per ton lower than former rates. Railway companies are seeking still further concessions, while the coalowners are standing out for more money. A considerable tonnage is being sent to North Lincolnshire and Derbyshire. Prices remain steady; good ordinary smelting coke selling at 11s. 6d. to 12s. 6d. per ton, according to the quality and quantity required.

The heavy trades of the city are in anything but a satisfactory condition. The long-expected armour orders have not been received up to the time of writing—the 17th inst.—but they may be placed any moment now. In fact, Mr. James F. Hope, M.P. for Brightside—the division of Sheffield in which the military material establishments are situated—has telegraphed to the effect that the orders for the armour for the battleships are out, and those for the cruisers may be expected next week. As the armour mills have been so long idle, while at the same time there is little doing in heavy forgings, railway material, and similar work, the employés at the East End are suffering severely. Relief operations have been started, with the principals of several of the large companies acting on the committee. A considerable sum has already been raised, and the subscriptions will be needed whether the orders come to hand at once or later.

Home railway companies are ordering very lightly, and no improvement is expected until the beginning of next quarter. Puddlers, steel melters, and others associated with the armour plate and military material departments generally have now had a long time of depression, and are not likely to spend a very joyous time in Coronation week. Next week promises to be one given up largely to holidays, and there is indeed little difficulty in the way, for work all round is exceedingly quiet. At the collieries Thursday, Friday, and Saturday will be "play days." For irons the rates at present current in Sheffield are:—West Coast hematites, 69s. to 70s. per ton; East Coast hematites, 63s. 6d. to 64s.; Lincolnshire forge iron, 49s. 6d. to 50s. 6d.; Lincolnshire foundry iron, 51s. to 52s.; bar iron, £6 10s.; Bessemer billets, £6 10s. to £6 15s.; Siemens-Martin billets, £7 to £7 5s.

In the lighter trades of the city there is complaint of the scarcity of orders, and the smallness of those received. The improvement previously noted in South Africa is continued, the cutlery trade, indeed, having doubled during the last month. There are better accounts also from New Zealand and Canada, but advices from Australia are not so encouraging, and fewer Sheffield goods than ever are being sent to United States markets. The outlook at present for the cutlery, silver, and plated ware trades is not at all hopeful, except on South African account.

NORTH OF ENGLAND.

(From our own Correspondent.)

GENERALLY the business doing in the iron and allied trades at present is described by producers as slack, and the only exceptions to this are to be found in the Cleveland pig iron and rail-making

branches. The shipbuilding and engineering industries, which were kept busy long after other departments were feeling the dulness, are now somewhat severely affected by depression, and this has led to the plate and angle making business becoming quiet, the hematite iron trade being slacker in consequence. It is now asserted by those connected with the shipbuilding industry that it is nearly ten years since their particular trade was in such an unsatisfactory condition as it is at present.

The situation in the Cleveland pig iron trade is fairly satisfactory, notwithstanding that a considerable quantity of Cleveland iron is going into the public warrant stores; there has, in fact, been a continuous increase in Connal's stores since the 4th inst., and the quantity held on Wednesday night reached 149,257 tons, this showing an increase of 5967 tons this month, and representing a larger quantity than has been reported for some years. In their own hands, however, the makers have not more than about three days' output stocked, and this is nearly all No. 3 quality, as that quantity also is in the public warrant stores. Consumers are not drawing on the stock in the public stores because, in the first place, it is dearer than makers' iron, and in the next, if they began to buy warrants, the price would be put up against them to higher figures still, and this would influence producers' prices upwards. Thus the large stock of Cleveland iron warrants hardly affects the general market at present. As regards the lower qualities of Cleveland pig iron, it may be reported that there is a dearth; makers have none in stock, and there is none in the public warrant stores, for only the higher qualities are lodged there. The difficulty in regard to these lower qualities now is not for the sellers to find buyers, but for the latter to meet with producers who are in a position to sell.

Makers of Cleveland pig iron are well off for orders for July and August execution, and thus, there being no pressure to sell, prices are maintained. Cleveland warrants have this week touched a price that has not been recorded for nearly two years, and, moreover, there is no longer a backwardation in the price for forward delivery. Makers of Cleveland iron more than hold their own in the matter of prices, and while the bulk of the business this week has been done at 49s. 3d. per ton for No. 3, prompt f.o.b. delivery, the leading makers have asked 49s. 6d., and that is the general figure now quoted, both by producers and merchants. Last week some of the sellers took 49s. per ton for deliveries to be made over the second half of the year, but that price has not met their views this week, and they will not take anything less than is quoted for prompt delivery. No. 4 Cleveland pig iron has been realising 48s. 9d. all the week; grey forge, 48s. 3d.; mottled, 47s. 9d.; and white, 47s. 3d., for both prompt and forward delivery.

The condition of the hematite pig iron trade in this district is anything but satisfactory to producers; in fact it may be said to be the least favourable branch of the iron and steel trades at the present time. This is due to the depression in shipbuilding, which has lessened the demand for steel plates and angles, and this district feels the slackening of operations at the shipyards more than any other, as the producers here rely on shipbuilders for finding them with so large a proportion of their work. The position of hematite iron makers is not improved by the fact that while their selling prices do not improve, the cost of production is increasing, as ore is rising in value, and the price of coke is also tending upwards. The quotation for mixed numbers of East Coast hematite pig iron is 57s. per ton, for No. 1 57s. 6d., and for No. 4 55s. Rubio ore has been put up to 15s. 9d. per ton delivered at wharf, Tees.

The steel rail trade shows considerable activity; in fact, not for two years have the manufacturers been so well provided with orders, and the price of heavy steel rails is strong at £5 10s. net at works. There is no improvement in the demand for railway chairs and metal sleepers. The plate makers' syndicate maintains the price of steel ship plates at £5 15s., less 2½ per cent., but demand is slack; they do not believe that any reduction in prices would bring in more orders, so they keep to their old rates. Steel ship angles are at £5 12s. 6d., less 2½ per cent. The bar makers' combination keeps to £6 5s., less 2½ per cent., as the official price of common iron bars, and other qualities in proportion.

A brisker inquiry has again sprung up from the United States for iron, and makers are expecting that if the miners' strike over there is not soon settled a considerable amount of business will be done. A sale of 5000 tons of hematite pig iron has within the last few days been made to American consumers by a Middlesbrough firm of merchants, and this week the steamer Laurelwood has loaded in the Tees a cargo of 3000 tons of hematite and spiegel iron for Philadelphia.

The first sod of the new light railway from Sinnington, on the Hilmsley and Pickering branch of the North-Eastern Railway, *vid* Lastingham to Rosedale, was cut on Saturday last by Mrs. Moncaster. The ceremony took place in a field near to the village of Rosedale Abbey, and a second sod was cut by Mr. F. Pope, of Lastingham, the promoter of the line.

It is stated that the North-Eastern Railway Company intends shortly to use oil for firing a number of its locomotives. Plant is being laid down at the locomotive running sheds at Gateshead for supplying the liquid fuel. A number of fire-box fittings for oil burning are also being prepared.

The demand for best coal has this week been active, but the same cannot be said of the second-class coal. Best steam coal has been raised in price, 11s. 6d. per ton f.o.b. being now generally quoted, and has not been very readily obtainable. Much of the best steam coal that will be raised next month is already sold. There has for the last few days been extra pressure for deliveries, as next week there will be little coal raised, for there will be at least three days' holiday. Coke makers have been able to get special prices for next week's delivery, but 15s. 3d. delivered at Teesside furnaces is the rate that will be taken for medium qualities over next half-year.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THERE has this week been a comparatively steady feeling in the Scotch iron trade. The home demand for raw iron has been rather better, and the advices from America are so encouraging that it is expected fairly good shipments may take place from here to the States. The near approach of the Coronation has, on the other hand, some effect in unsettling business for the time.

The pig iron warrant market has been comparatively quiet. Scotch warrants are scarce, and very little business has been done in them. The prices are about 54s. 3d. cash, and 54s. 6d. one month, sellers asking a little more. Business has been done in Cleveland warrants from 49s. 8d. to 49s. 6½d. cash, and at 49s. 9d. and 49s. 8½d. one month. Cumberland hematite is quiet, but steady. A small quantity of this iron changed hands at 60s. cash, and 60s. 3d. is quoted for delivery in one month.

There is steady business in Scotch hematite pig iron, which is quoted by makers 62s. per ton for delivery at the West of Scotland steel works.

The prices of Scotch makers' iron have been firmer. G.M.B., No. 1, is quoted at Glasgow f.a.s., 55s. 9d.; No. 3, 53s. 6d.; Wishaw, No. 1, 56s. 3d.; No. 3, 53s. 6d.; Carnbroe, No. 1, 57s. 6d.; No. 3, 54s.; Clyde, No. 1, 66s.; No. 3, 56s.; Gartsherrie and Calder, Nos. 1, 66s. 6d.; Nos. 3, 56s. 6d.; Summerlee and Coltness, Nos. 1, 70s.; Nos. 3, 58s.; Langloan, No. 1, 70s.; No. 3, 59s.; Glengarnock, at Ardrossan, No. 1, 66s. 6d.; No. 3, 56s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 57s.; No. 3, 53s. 6d.; Dalmellington at Ayr, No. 1, 56s.; No. 3, 53s.; Shotts at Leith, No. 1, 69s.; No. 3, 58s.; Carron at Grangemouth, No. 1, 68s.; No. 3, 58s. per ton.

The shipments of pig iron from Scottish ports in the past week amounted to 7274 tons, compared with 6113 in the corresponding week of last year. Of the total there was shipped to the United States 1450 tons, Canada 820, South America 300, Australia 185, Holland 150, Germany 20, India 119, Spain 20, China and Japan 115, other countries 236, the coastwise shipments being 3859, against 3973 in the corresponding week. The total shipments to date are 140,754 tons, compared with 127,922 in the same period of last year. Our largest customer this year has been the United States, with nearly 12,000 tons, while Italy comes next with almost 9000 tons.

The arrivals of Middlesbrough pigs at Grangemouth in the past week were 11,282 tons, showing an increase of 3477 over the quantity imported in the corresponding week of 1901.

There are 44 furnaces producing hematite pig iron, 38 ordinary, and 4 basic, the total of 86 thus blowing in Scotland comparing with 80 at this time last year.

Notwithstanding that the output of iron is so large, it is not believed that makers are adding materially to their private stocks, while the stock of pig iron in the Glasgow warrant stores continues to show a small decrease week by week.

There is a rather better feeling in the finished iron and steel trades. Most of the works are kept steadily going, and the outlook is fairly promising, although in some cases makers have of late found it a little difficult to maintain full output. They have not had much work in hand to look forward to, but still somehow the orders have been available when required to keep the works in operation. There are different opinions among makers as to whether the combination to maintain prices will do very much good. No doubt if adhered to freely it will steady the rates, but it is felt that a considerable increase of business upon that presently enjoyed will be required before there is much improvement in prices.

In the case of shipbuilding material rates are somewhat better, and ship plates have been raised 2s. 6d. per ton, making the price £5 17s. 6d., less the usual 5 per cent. discount.

The coal trade continues well employed. The shipments from Scottish ports in the past week amounted to 218,038 tons, compared with 196,194 in the preceding week and 215,914 in the corresponding week of last year. There is also a very good demand for house coal for home consumption. At the same time the colliers have been working so steadily that the supplies in a number of districts are outrunning the demand, and coals are accumulating in railway wagons. In this way the wagons are not available for immediate traffic, and those who have prompt orders to execute find it difficult in some cases to get the coal forward to the ship's side. There is a very good demand for manufacturing purposes, and prices are on the whole fairly steady. Main coal is quoted f.o.b. at Glasgow, 8s.; splint, 9s. to 9s. 6d.; steam, 9s. 6d. to 9s. 9d.; and ell, 9s. 3d. to 10s. per ton.

The coalmasters have intimated to the Conciliation Board that they require a reduction in the miners' wages owing to the falling prices. The proposal of the masters is that there should be a reduction of 12½ per cent., and the matter has been under the consideration of the Conciliation Board for the last few days. The reductions made in England show that trade has been going back in the matter of prices all over.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

THERE has been a fair demand for best steam coal of late, and prices have been maintained. This week a slightly easier tone characterised some of the Monmouthshire varieties, and house coal continued to decline. In this class of coal the fall would have been more pronounced but for the variable weather. Swansea coal shipments last week were above the average, and it was noticeable that while buyers in France showed a falling off, San Francisco and Italy indicated improvement. Cardiff despatched a large quantity of coal to Malta at the beginning of the week. Small steam is in demand, and quotations are tolerably firm. The latest Cardiff prices are:—Best steam, 16s. to 16s. 3d. Since the improvement set in some sales of best are stated to have touched 16s. 6d. Steam fell for June in respect of leading coals. Seconds are at 15s. to 15s. 6d.; drys, 14s. to 14s. 6d.; best small, 7s. 6d. to 7s. 9d.; seconds, 7s. to 7s. 3d.; other kinds, including drys, 6s. 6d. to 6s. 9d.; best Monmouthshire, 13s. 6d.; seconds, 12s. to 12s. 3d.; best semi-bituminous, small, 7s. to 7s. 3d.; seconds, 6s. to 6s. 3d.; best household, 15s. to 15s. 6d.; seconds, 11s. 6d. to 14s.; No. 3 Rhondda, 14s.; brush, 11s. 9d. to 12s.; small, 9s. 3d. to 9s. 6d.; No. 2 Rhondda, 10s. 9d. to 11s.; through, 8s. 6d. to 9s. 6d.; small, 6s. 6d.; patent fuel, 15s. to 16s. Coke continues in strong demand, furnace at 17s. to 19s.; good foundry, 20s. to 22s.; and special, 23s. to 23s. 6d. Pitwood from 19s., or 6d. per ton easier on account of large imports. French wood continues to take the lead in values. Irish coming in freely this week.

Anthracite market continues steady and hopeful, but this week has been rather quiet. Latest prices: Best malting large, 21s.; second malting, 18s. 6d.; big vein, 16s. 6d. to 17s.; red vein, 12s. 3d. to 12s. 6d.; machine-made cobbles, 21s. to 22s.; ditto nuts, 24s.; ditto rough peas, 11s. 6d. to 12s.; ditto fine peas, 11s. 6d. to 12s.; rubbly culm, 5s. to 5s. 6d.; duff, 3s. to 3s. 6d.

Latest bituminous prices: No. 3 Rhondda, 14s. 6d. to 15s. 6d.; through coal, 12s. to 12s. 6d.; small, 10s. to 10s. 6d.; No. 2 Rhondda, 11s. 6d. to 12s. 6d. These figures indicate an advance since Monday. Mid-week steam coal prices were:—Best, 15s. to 15s. 6d.; seconds, 12s. 6d.; bunkers, 9s. 9d.; small, 7s. Patent fuel is at 14s. 6d. to 15s.; over 12,000 tons were despatched last week. Coke active; 17s. to 18s. furnace; foundry, 21s. to 22s. Pitwood, 20s. into truck; all Swansea. These figures are coupled with the intimation of cash 30 days, less 2½.

Last week another large quantity of steel bars—over 2000 tons—came to Newport from Antwerp. This totals up to a very large import during the last three months, and accounts for much of the depression at local steel works.

Very high comment was elicited at Port Talbot this week regarding the enterprise of Gilbertson and Son with their new steel works, which were cited to be of the most modern type, with all the latest improvements, and a practical rejoinder to American rivalry. I have been lately in the colliery district, which promises to be a good feeder to the new port. The Avon Valley is one of the future areas of supply, and now is comparatively undeveloped to the east, while the Duffryn Valley to the south is practically a maiden coalfield.

A new branch of the British Steel Smelters' Amalgamated Association has been formed at Port Talbot.

Very favourable comment is passed in the Swansea Valley upon the enterprise of THE ENGINEER in sending a special agent to report upon the opening out of South Africa to home engineering and manufacturing industries. Leading firms of tin-plate works and associated industries are confident that a great future is in store, and all that is needed is skilled direction in the preliminary movements that are necessary.

The most important steel rail despatch of the week has been 500 tons to Liverpool, but it is understood that important cargoes are preparing.

In the Swansea district a large demand exists for local tin-plate bars, and the pig iron trade is well in evidence, with a good tone. The associated industries are active, and the Mannesmann is working overtime.

At the Bessemer works, Dowlais, great alterations are in development, and it is probable that further reduction of hands will take place, with manifest improvements in the engineering and mechanical direction, and in the addition of electric power. Steel sleepers in demand, and mills are busy. Rail straighteners' dispute has been adjusted.

In the Swansea tin-plate district a healthy condition exists, and in tin-plate districts generally—Carmarthenshire, Monmouthshire, and Gloucestershire. Thus, the action of the steel smelters' union, in supporting the Swansea workers' demand, promises to nullify, as these labour movements are generally contagious.

There was a large make of tin-plates last week, and owing to delayed tonnage an increase in stock, which is now over 169,000 boxes. Loadings are going on for Batoum and Odessa, which have not been conspicuous of late. Pontardawe will have eleven mills in action shortly. Sheets are in good demand.

Latest general prices this week were as follows:—Glasgow pig iron warrants, 54s. 6d. cash; Middlesbrough No. 3, 49s. 6½d. to 49s. 7d., other numbers in proportion; hematite warrants, 60s. 1½d. for mixed numbers; Welsh bars, £6 5s. to £6 10s.; sheets, iron and steel, £8 5s. to £8 10s.; steel rails, heavy sections, £5 10s. to £5 12s. 6d.; light, £6 10s. to £7 12s. 6d.; sleepers, angles, &c., according to specification; Bessemer steel tin-plate bars, £5 2s. 6d.; Siemens best, £5 5s. Tin-plates: Bessemer steel coke, 13s. 9d. to 14s.; Siemens, coke finish, 14s. to 14s. 3d.; ternes, per double box, 28 by 20 C. 26s., 27s. to 28s. 6d.; best charcoal, 15s. 6d. to 16s. 6d.; big sheets for galvanising, 6ft. by 3ft. by 20 g. per ton f.o.t., £11 to £11 5s.; block tin, £130 to £125 15s.; spelter, £18 15s.; lead, £11 10s.; copper, Chili bars, £54 5s. to £54 7s. 6d. at Swansea.

At Cardiff and Newport the latest iron prices were:—Almeria, 14s. 3d. to 14s. 6d.; Rubio, 14s. 3d. to 14s. 6d.; Tafna, 15s. to 15s. 6d. Ore has come in largely for Ebbw Vale from Bilbao; pig iron from Grimsby, Barrow, and Whitehaven. Briton Ferry is importing steel rails and ingot moulds from Barrow.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

EXCEPT that demand in a few cases has been stronger than last week, no alterations can be stated to have taken place on the iron market over here.

The Silesian ironworks have again been securing more orders from Russia, and the various branches of the finished iron industry are generally well occupied, sheets and hoops having been last week in particularly good request both for inland and foreign consumption. The shipbuilding and engineering establishments have also been briskly engaged, and have placed some contracts of fair weights recently. On the pig iron market inquiries have increased, but the amount of orders actually secured is comparatively small; quotations are stiff. A quiet sort of trade continues to be transacted on the Rhenish-Westphalian iron market, the majority of the iron-producing establishments being engaged on orders of previous booking. During the past few weeks only a very small number of forward orders have been secured, and some shops complain of being but very insufficiently supplied with fresh work. The ending of the war in Africa is not expected to have any particularly improving influence on the German iron business, at least not for the next few months; after some time, however, the general revival that is sure to follow the depression and dulness which prevailed in most trades during the period of the war cannot fail to have a favourable influence on the German market for iron and steel. In the crude iron business, demand is slack and not sufficient to cause a decrease in stocks, and the activity of the blast furnaces is moderate; prices have not altered, and they certainly cannot be expected to move in an upward direction under the present circumstances.

The German coal market has been a little more animated this week than last. The decrease of the stores in the Ruhr harbours, and the report that the strike of the American colliers increases, acted as a stimulant on the coal trade over here; there have again been inquiries for steam coal coming in from abroad, and coal for coke-making is in very good call on local account. The securing of the late contract for the Prussian State railways has been an event of some importance to the German coalowners, not merely on account of the weight of the order, but also because the contract was placed at the former price of M. 11 p.t., while at first only M. 10·80 p.t. were expected to be given.

A limited business is done in iron and steel on the Austro-Hungarian market. Pig iron, as well as bars and sheets, have continued in regular demand, while the machine department is weakly occupied.

A perfectly hopeless condition prevails on the Austro-Hungarian coal market.

In Belgium the iron industry remains quiet, but a pretty firm tone prevails generally, and the majority of the works are well employed. In the Liège district Cockerill, the Société Ougrée and the Société Angleur are in specially good activity, having secured work for many weeks ahead. Also in the Charleroi district a regular occupation is reported to continue in most branches of the iron and steel industry. The finished iron works, with few exceptions, are doing an unsatisfactory sort of business, so far as prices are concerned; the profit realised is hardly worth speaking of, as it not unfrequently happens that the mills accept orders at almost the same prices which they have to pay for the raw material.

Coal is but weakly called for in Belgium. Prices are the same as in previous weeks, but they have been showing a fair stiffness. Coke is exceedingly firm at 18f. to 20f. p.t. By an official statement that was recently given, the import in coal to Belgium is shown to have been 285,477 t. for April of present year, against 221,638 t. for the same month last year, the increase being chiefly due to the Belgian colliers' strike. Import in coke also rose strongly, being 18,405 t., against 9364 t. in April, 1901. During the first four months of the present year import in coal to Belgium was 1,025,521 t., against 852,463 t. for the corresponding period the year before. German import in coal to Belgium was 184,000 t. higher this year than last during the period above mentioned. Export of coal shows a decrease for April, 272,605 t. having been exported, against 294,638 t. last year; coke decreased from 65,655 t. on 50,231 t.

In France the position all round continues unsatisfactory on the iron market. Now and then an improvement can be noticed, and, however slight these improvements may be, they are instantly commented upon and generally regarded as the symptoms of a revival; but, as a rule, these upward movements only take place in special cases, and, moreover, they are of short duration, too, and although prices have been showing an undesirable tendency to harden, they still leave very much to be desired. Orders come in pretty regularly, but they are mostly for immediate consumption; forward contracts are complained of as being scarce.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal market firm, and stems well filled to the end of the month. House coal remains unaltered. Exports for week ending June 14th: Coal, foreign, 27,230 tons; coastwise, 21,681 tons. Imports for week ending June 17th: Iron ore, 8726 tons; pig iron, 2300 tons; old rails, 305 tons; boards, 808 loads; pitwood, 1057 loads.

Coal: Best steam, 13s. 3d. to 13s. 6d.; seconds, 11s. 9d. to 12s.; house coal, best, 15s.; dock screenings, 8s.; colliery small, 7s. 3d. to 7s. 6d. Pig iron: Scotch warrants, 54s. 9d.; hematite warrants, 60s. 3d. f.o.b. Cumberland prompt; Middlesbrough, No. 3, 49s. 10d. Iron ore: Rubio, 15s.; Tafna, 15s. to 15s. 6d. Steel: Rails, heavy sections, £5 10s. to £5 12s. 6d.; light sections, £6 10s. to £7 10s. f.o.b.; Bessemer steel tin-plate bars, £5 2s. 6d.; Siemens steel tin-plate bars, £5 5s., all delivered in the district, cash. Tin-plates: Bessemer steel coke, 13s. 9d. to 14s.; Siemens, coke finish, 14s. to 14s. 3d. Pitwood: 19s., ex ship. London Exchange telegrams: Copper, £53 15s.; Straits tin, £127. Freights easy.

TRADE AND BUSINESS ANNOUNCEMENTS.

MR. J. H. WHIELDON, consulting engineer, has opened offices at Portland House, Commissioner-street, Johannesburg.

THE directors of Galloways Limited, Manchester, have declared an interim dividend at the rate of 5 per cent. per annum on the preference shares.

D. BRUCE PEEBLES AND CO., Edinburgh, have received the order for electrical generating plant, to the value of £8371, for the Natal-Durban Railway Government railway shops.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

☞ When inventions have been "communicated" the name and address of the communicating party are printed in italics.

3rd June, 1902.

12,646. APPARATUS for EXERCISING, E. Lambe, Birmingham.
12,647. CYCLE BRAKE, W. Pilling, London.
12,648. KILNS for BURNING BRICKS, E. Jenkinson, London.
12,649. RIVET MACHINES, M. L. Stangeland, Cleveland, Ohio, United States.
12,650. KILNS, M. Williams, London.
12,651. TOYS, C. Turner and E. Vickers, Birmingham.
12,652. CANDLE EXTINGUISHERS, M. J. Nuth, Brynmawr, Breconshire.
12,653. NEEDLE THREADER, E. and A. E. Winslade, Farnham, Surrey.
12,654. RACQUETS for LAWN TENNIS, H. Lüders, Berlin.
12,655. COLLAPSIBLE BOXES, J. T. Cartright, Hyde, Cheshire.
12,656. DOMESTIC SHOVEL, F. White, London.
12,657. GAME, A. K. Tebby, London.
12,658. ORDNANCE, A. Reichwald.—(*F. Krupp, Germany.*)
12,659. FLUID-PRESSURE ENGINES, W. E. J. Vavasour, London.
12,660. PHOTOGRAPHIC CAMERAS, W. C. Grubb, London.
12,661. STEAM BOILERS, L. Lewichi, London.
12,662. SPECTACLES, E. L. Lembke, London.
12,663. CONTRACTIBLE MANDRILS, E. H. Forwood, London.
12,664. TOYS, H. V. Lough, London.
12,665. HAND BRAKES for VEHICLES, S. Stückgold, London.
12,666. AUTOMATIC VEHICLE COUPLINGS, S. Stückgold, London.
12,667. WIRE HEDDLE-MAKING MACHINE, J. F. Eger, London.
12,668. MUSICAL INSTRUMENT MECHANISM, H. H. Lake. —(*The Æolian Company, United States.*)
12,669. EYEGLASSES, F. A. Stevens and A. E. Lenz, London.
12,670. FASTENINGS for CLOTHING, J. M. Duffy, London.
12,671. TELEPHONE SYSTEMS, C. G. Burke, London.
12,672. CONVEYOR CHAINS, S. von Clanner and K. von Jekey, London.
12,673. BUFFERS for RAILWAY VEHICLES, A. Spencer, London.
12,674. HANGING PICTURE FRAMES, G. Johnson, London.
12,675. MAKING PNEUMATIC TIRES, J. W. Blodgett, London.
12,676. CLOSURE for GARMENTS for LACING, C. B. Howd, London.
12,677. FIRE-ARM TRIGGER MECHANISM, E. D. Fulford, London.
12,678. REFRIGERATING APPARATUS, W. W. Harris, London.
12,679. BOX CARS, P. Jensen.—(*The Transportation Development Company, United States.*)
12,680. MANUFACTURE of PAINTS and DYES, R. Vidal, London.
12,681. CARBON ARTICLES, C. M. Hall, London.
12,682. STREET LANTERNS, W. Edgar, London.
12,683. PATTERN SHEETS or CARDS, E. A. Roskilly, London.
12,684. PREVENTING LEAKAGE of ELECTRIC CURRENT, W. Griffiths and B. H. Bedell, London.
12,685. HAMMERING MACHINES, C. G. Hagbom, London.
12,686. HOOKS and EYES for DRESSES, M. E. Widdicombe, London.
12,687. SOCKET JOINTS for PIPES, W. Cadman, London.
12,688. POLYPHASE CURRENT TRANSFORMERS, W. P. Thompson. — (*Berliner Maschinenbau-Actien-Gesellschaft vormals L. Schwartzkopff, Germany.*)
12,689. ELECTRIC SWITCH and WALL PLUG, A. Vandam, London.
12,690. TYPE-JUSTIFYING APPARATUS, W. P. Thompson. —(*F. Holdsworth*, ———.)
12,691. ELECTROLYTIC DECOMPOSITION APPARATUS, H. Cuénod and C. Fournier, Liverpool.
12,692. VAULTS, A. J. Boult.—(*The Hall's Safe and Lock Company, United States.*)
12,693. FOLDING CYCLES, M. Türkheimer, London.
12,694. DYNAMO-ELECTRIC MACHINE COILS, L. Lohner and F. Porsche, London.
12,695. VEHICLE-STEERING DEVICE, F. Porsche and L. Lohner, London.
12,696. BREECH-LOADING RIFLES, R. M. Basilone, London.
12,697. PERFORATOR for TELEGRAPH TRANSMITTERS, A. Muirhead, London.
12,698. WATER GAUGES for BOILERS, E. F. Shallow, London.
12,699. ROTARY MOTORS, J. M. Keegan.—(*C. V. du Toit, South Africa.*)
12,700. MATERIAL for ACCUMULATOR PLATES, S. A. Rosenthal, London.
12,701. COUNTING MACHINE, S. Evershed and Evershed and Vignoles, Limited, London.
12,702. ELECTRIC PRODUCTION of IRON ALLOYS, G. Gin, London.
12,703. FREEZING MACHINE, J. B. Schäfer, London.
12,704. BRAKE and CLUTCH for VEHICLES, L. Renault, London.
12,705. PHOTOGRAPHIC ROLLER FILMS, M. Kuhnt, London.
12,706. WIRELESS TELEGRAPH SYSTEMS, C. D. Ehret, London.
12,707. STEAM ENGINE INDICATORS, T. Davidson, London.
12,708. METALLIC CLAMPING DEVICE, E. C. Glardon, London.
12,709. STEAM GENERATORS, A. W. Ofeldt, London.
12,710. AIR and GAS-MIXING APPARATUS, G. A. Loeben, London.
12,711. STEAM BOILERS, E. J. Moore, London.
12,712. APPARATUS for HEATING WATER, H. Junkers, London.

4th June, 1902.

12,713. MAKING SALT, R. Hodgson and J. E. Rowley, Birmingham.
12,714. SAWING MACHINE, C. H. Clifton, Johnstone, Renfrewshire.
12,715. IGNITION ARRANGEMENTS, F. W. Lanchester, Birmingham.
12,716. ROUNDABOUT or MERRY-GO-ROUND, J. Steele, Manchester.
12,717. CALENDERING TEXTILE FABRICS, R. Williams, Manchester.
12,718. LOOM SHUTTLES, T. Hardy, Burnley.
12,719. FILLING BOTTLES, W. B. Dixon, J. Whewell, and I. Haworth, Burnley.
12,720. CASK BUSHES, J. Ross and A. W. Mackenzie, Edinburgh.
12,721. COUPLINGS for RAILWAY VEHICLES, G. H. Bangay, Bristol.
12,722. MACHINE for SEALING BOTTLES, A. E. Hull-Perry, Leicester.
12,723. SERVING AERATED WATERS on DRAUGHT, J. P. Jackson, Liverpool.
12,724. PACKING for STUFFING-BOXES, J. J. Galloway, Glasgow.
12,725. VOICINE, J. Davidson, Newcastle-on-Tyne.
12,726. LETTER BOOKS, E. W. Allen and H. J. Davies, Bristol.
12,727. ATTACHING COLLARS to GARMENTS, T. Charlan, Manchester.
12,728. RIFLE RANGES, J. MacNaughton, Glasgow.
12,729. MEASURING TEXTILE WARPS, E. Taylor, Manchester.
12,730. ARCH PIPE, H. W. Woodall, H. C. Head, and W. H. Green, Bournemouth.
12,731. "THE EVERDRY," J. W. Mellor and L. Wolstenholme, Oldham, Lancs.
12,732. ANCHORS, A. W. Baxter, London.
12,733. ELECTRIC DOOR CONTACT, F. E. Linnett, Northampton.
12,734. AUTOMATIC CANDLE EXTINGUISHER, M. Marcus, Glasgow.
12,735. IMPROVED PETROLEUM LAMP, E. Menge, Birmingham.
12,736. RELIEF VALVES, J. W. Mackenzie.—(*F. Schriedt, United States.*)
12,737. BLOWING-OFF MACHINE for LAMP BULBS, A. Swan, Leeds.
12,738. INCANDESCENT ELECTRIC LAMPS, A. Swan, Leeds.
12,739. INCANDESCENT ELECTRIC LAMPS, A. Swan, Leeds.
12,740. PIPE CLEANER, J. K. Roberts, London.
12,741. TIRES, F. Holcombe, Cardiff.
12,742. PROCESS for ATTAINING a COLOURED FLAME, E. Delbermann, Cologne, Germany.
12,743. TREATING GRAIN, M. and H. Guthrie, Birmingham.
12,744. BLEACHING POWDER, M. and H. Guthrie, Birmingham.
12,745. COAL STOPS for INCLINED RETORTS, M. Graham, London.
12,746. DISCHARGING INCLINED RETORTS, W. R. Herring, London.
12,747. CHARGING INCLINED RETORTS, W. R. Herring, London.
12,748. TARGETS, A. Pickles, London.
12,749. ELECTRICAL COMMUNICATIONS, C. M. A. and F. V. Culverhouse, London.
12,750. SCREW CUTTING MACHINES, A. Herbert, London.
12,751. REMOVABLE LINING for TROUSERS, E. Stahl, London.
12,752. TESTING ELECTRIC CABLES, E. A. Claremont and C. J. Beaver, London.
12,753. CASEMENT STAY, Tonks, Limited, and W. Sparks, London.
12,754. ACETYLENE LAMPS, H. W. Webb and F. A. Wright, London.
12,755. REDUCING SYCHRONISING CURRENTS, E. Kolben, London.
12,756. SELF-PLAYING PIANOS, J. Wieser and K. Fink, London.
12,757. GENERATION of MOTIVE POWER, P. C. Louat, London.
12,758. MACHINE for MOULDING DOUGH, G. F. Chutter, Birmingham.
12,759. ORNAMENTAL TUBES for BEDSTEADS, G. A. Edman, Birmingham.
12,760. BASE FUSES for PROJECTILES, C M. Broderick London.
12,761. FOLDING GATES, D. Dore and J. J. Holmes, London.
12,762. MAKING PORTLAND CEMENT, W. H. Martin, London.
12,763. TELESCOPIC WHIP, H. Bode, London.
12,764. BRUSH HOLDERS, H. H. Lake.—(*General Electric Company, United States.*)
12,765. DISTRIBUTION of ELECTRICITY, H. H. Lake — (*General Electric Company, United States.*)
12,766. CLEANING LAMP FILAMENTS, H. H. Lake.— (*General Electric Company, United States.*)
12,767. CONTROL OF ELECTRIC MOTORS, H. H. Lake.— (*General Electric Company, United States.*)
12,768. OPTICAL APPARATUS, A. J. Boult.—(*L. Rancoule, France.*)
12,769. ADJUSTABLE PENCIL HOLDER, J. C. P. Webber, Plymouth.
12,770. SUPPORTS for MUSICAL INSTRUMENTS, A. Olsen, London.
12,771. CIGARETTE TUBES, P. A. Newton. — (*The American Tobacco Company, United States.*)
12,772. PNEUMATIC TIRES for CYCLES, H. A. Goodyer, London.
12,773. STRAINERS, E. Springborn and A. Burnie, London.
12,774. PREVENTING UNAUTHORISED USE of BICYCLES, A. Haug, London.
12,775. TYPE CASTING METAL PUMP VALVE, F. E. Peacock, London.
12,776. SPOOL WINDERS for ROLL FILMS, H. F. Purser, London.
12,777. IMPROVED STOPPER for BOTTLES, F. A. Schouten, London.
12,778. ORES, H. H. Lake.—(*A. Froment, Italy.*)
12,779. COPYING PRESSES, H. H. Lake.—(*E. Senigaglia, Italy.*)
12,780. TELEPHONE INSTALLATIONS, P. Hardegen, London.
12,781. APPARATUS for TREATING GAS, S. and J. Chandler, London.
12,782. ROPE HAULAGE for LIFTS, Siemens Bros. and Co., Limited.—(*Siemens and Halske Aktien-Gesellschaft, Germany.*)
12,783. ELECTRO-MAGNETIC DETENTS, Siemens Bros. and Co., Limited, and A. Siemens, London.
12,784. FOLDING CARD, J. Ehrsam, London.
12,785. STOPPERS for BOTTLES, L. Hoeglauer, Liverpool.
12,786. INDICATING at a DISTANCE DISPLACEMENTS of SOLID or FLUID BODIES, F. Beck, London.
12,787. SEPARATING DUST from AIR, J. Sugden, London.
12,788. STERILISING DRINKING WATERS, O. Kaysser, London.
12,789. HAY-MAKING MACHINE, M. F. F. Keelhoff, London.
12,790. PROFILING MACHINES, H. Schuberth, London.
12,791. ROAD VEHICLES, P. F. Vincent, London.
12,792. PHOTOGRAPHIC FILMS, A. Weiss, London.
12,793. ELECTROLYTIC REFINING of COPPER, The Metals Corporation, Limited, and S. Cowper-Coles, London.
12,794. FLOORS, H. Foort, London.
12,795. STEAM PURIFIERS, L. M. G. Delaunay-Belleville, London.
12,796. MANUFACTURE of CERAMIC, J. Y. Johnson.—(*C. F. Boehringer and Söhne, Germany.*)
12,797. MECHANICAL MOVEMENTS, W. L. Wise.—(*The Richmond Cedar Works, United States.*)
12,798. COUPLINGS for RAILWAY CARRIAGES, T. Murphy, London.
12,799. AUTOMATIC SMALL-ARMS, T. C. Johnson, London.
12,800. BEARINGS, H. A. Mavor, London.
12,801. ACTUATING TOY FIGURES, J. Renvoize, London.

5th June, 1902.

12,802. PIPE COVERING OPENING and CLOSING AUTOMATICALLY, H. Turner and Sons, Birmingham.
12,803. DUPLICATING SALES CHECK BOOK, G. O. and A. E. Woolley and E. Parker, Bristol.
12,804. TESTING and STRAIGHTENING GUN BARRELS, The Birmingham Small-arms Company, Limited, A. H. M. Driver, and G. Norman, Birmingham.
12,805. BORING the BARRELS of SMALL-ARMS, The Birmingham Small-arms Company, Limited, A. H. M. Drive, and G. Norman, Birmingham.
12,806. ONE-REVOLUTION CYCLE OPERATIONS, J. G. H. Batchelor, Birmingham.
12,807. RENDERING FABRICS WATERPROOF, J. Menzies, London.
12,808. CRATE for PACKING EARTHENWARE, R. L. Boote, Burslem, Staffs.
12,809. NEW POLISHER, T. Wild and H. Barton, Bury.
12,810. SIFTING SMALL PARTICLES from a GENERAL Mass of MATTER, B. H. Jones and J. W. Holland, Wolverhampton.
12,811. RAISING SUNKEN VESSELS, J. J. Peirce, Glasgow.
12,812. TOOLHOLDERS, W. C. Smith and H. M. Cockaday, Manchester.
12,813. TRAMCAR SEATS, R. Billington, jun., Blackpool.
12,814. CONCERTED MODELLING GAME, W. Harbutt, Bathampton, Somerset.
12,815. COVERING the FRAMES of SLIDING WINDOWS, H. Williams, Manchester.
12,816. APPARATUS for POTTERS' SLIPS, J. Critchlow, Manchester.
12,817. ELECTRIC SWITCHES, M. Mercier and W. O. Andrews, Manchester.
12,818. NON-EXPLOSIVE PHOTOGRAPHIC FILM, S. G. Fry, Liverpool.
12,819. PENDULOUS CONTRIVANCE for ADVERTISEMENT CARTOONS, E. E. Sparyo, Glasgow.
12,820. CONSTRUCTION of SMOKING PIPES, A. F. Jonas, Sheffield.
12,821. MECHANICAL MONEY-BOX, P. Cowe, Berwick-on-Tweed.
12,822. COVER for EXPOSED SEATS, E. and W. E. Butt, Bradford.
12,823. ELECTRICAL MEASURING INSTRUMENTS, A. C. Heap and W. O. Smith, London.
12,824. BRAKES for AUTOCARS, The Hozier Engineering Company, Limited, and A. Govan, Glasgow.
12,825. A COPPER-BIT SOLDERING IRON, F. H. Bate, Stourbridge.
12,826. INTERLOCKING APPARATUS for RAILWAY SIGNALLING, W. Buck, Manchester.
12,827. SMOKE-CONSUMMING APPLIANCE, C. Kleycr, Baden, Germany.
12,828. RING for ANGLING RODS, W. Humphries, Studley, Warwickshire.
12,829. ACETYLENE GAS GENERATORS, J. H. Ross, Birmingham.
12,830. APPARATUS for DRYING GRAIN, W. J. Menzies, Derby.
12,831. WARP BALLING MACHINES, T. Holt, Limited, and A. Seeley, Manchester.
12,832. COLLAPSIBLE SEATS, C. Turner, Broadstairs, Kent.
12,833. BRICKS for CROWNS of FURNACES, G. V. Evers, London.
12,834. METALLURGICAL CONVERTERS, A. Reynolds, London.
12,835. SAFETY ENVELOPE, J. J. A. Cart and F. Flower, London.
12,836. COLLARS, C. C. Parker, London.
12,837. EXTRACTING METALS from ORES, J. B. de Alzuguaray, London.
12,838. VEHICLE-RUNNING GEARS, G. H. and A. T. Sherman, London.
12,839. OPENING OUT TEXTILE PIECE GOODS, W. Mycock, Manchester.
12,840. FASTENERS for LADIES' DRESSES, L. Cross, London.
12,841. BOOT-FASTENING ARRANGEMENT, J. G. Butler, London.
12,842. TABLE GAME, W. Bragg, London.
12,843. DRYING TOBACCO, C. A. Day.—(*The Moseley Dryer Company, United States.*)
12,844. DRAG PLATES for REGULATING TENSION in SPINNING MACHINERY, P. Clough and R. Wadsworth, London.
12,845. MOTOR CYCLES, W. J. Lloyd and W. Priest, London.
12,846. ELECTRIC SWITCH, J. Bush and M. T. Medway, London.
12,847. GAS MOTOR ENGINES, F. W. Lanchester, Birmingham.
12,848. POWER-PROPELLED VEHICLES, F. W. Lanchester, Birmingham.
12,849. MACHINES for FILLING BOTTLES, J. Haile, London.
12,850. BAGS, B. Bloom, London.
12,851. ASCERTAINING a SHIP'S POSITION, H. D. Jones, London.
12,852. GILDING BOOK EDGES, E. C. Lea and R. C. Hazell, London.
12,853. INSTRUMENTS for DRAWING, J. W. Mander, London.
12,854. HYDRAULIC PRESSES, O. Philipp, London.
12,855. INDICATING the DESTINATION of GOODS, F. Rossnick, London.
12,856. LATCH-NEEDLES, J. A. Seyfert, London.
12,857. STORAGE BATTERIES, W. E. Winship, London.
12,858. BOXING MATCHES, Bryant and May, Limited, and E. Thorp, London.
12,859. PROCESS for OBTAINING ZINC, E. H. Hopkins, London.
12,860. PROJECTILES, J. B. Semple, London.
12,861. MARBLE, T. M. Thom, London.
12,862. ORTHOPTICS, A. A. Common, London.
12,863. MEANS for USE in CLEANING LAWNS, A. Payne, London.
12,864. TRUCKS for RAILWAY PLATFORMS, J. Taylor, London.
12,865. CLOTH-MILLING MACHINERY, J. N. Bromley, London.
12,866. FLYING MACHINES, H. F. Phillips, London.
12,867. FLUID-PURIFYING APPARATUS, R. G. Brooke, London.
12,868. MACHINE for POWDERING ICE, L. Murat, London.
12,869. WASHING PLATES, J. Gries and C. Hartmann, London.
12,870. APPARATUS for CHARGING ELECTRIC ACCUMULATORS, Société Lespagnol and Mériguet, London.
12,871. OBTAINING OSCILLATORY MOTION, H. H. Young, London.
12,872. OIL ENGINE, T. J. Simmons, London.
12,873. TURBINES or ROTARY ENGINES, T. J. J. Wasley, London.
12,874. GAME, J. Fliess, London.
12,875. SEPARATING OIL from STEAM, A. E. Krause, London.
12,876. PNEUMATIC CLOTHING RENOVATORS, J. S. Thurman, London.
12,877. VAPORISING DISINFECTANTS, A. R. von Zarewicz, London.
12,878. INCANDESCENT BURNERS, R. Haddan.—(*The Aktien Gesellschaft für Fabrikation von Broncewaaren und Zinkguss vormals J. C. Spinn and Sohn, Germany.*)
12,879. BASKETS, J. Y. Johnson.—(*W. M. and E. J. Morris, United States.*)
12,880. PREPARING RESINOUS SUBSTANCES, L. Blumer, London.
12,881. ELECTRIC RESISTANCES and SAFETY FUSES, G. H. Fawcus, London.
12,882. MANUFACTURE of DRUMS, E. H. Forwood, London.
12,883. SASH FASTENING, J. A. Taylor, London.
12,884. CLEANSING FLOOR SURFACES, J. S. Stewart-Wallace, London.

6th June, 1902.

12,885. WEAVING TUBULAR TIES, J. Cryer and J. Webster, London.
12,886. CHEST of DRAWERS, C. Tuckfield and W. G. de F. Garland, East Molesey, Surrey.
12,887. CHAIN LINKS, J. P. Barker and A. Fitt, Ipswich.
12,888. ICE MAKING, W. B. Warner and R. J. Eskrigge, Leicester.
12,889. WEIGHING APPARATUS for CRANES, H. Gray, London.
12,890. MEAT SAFES, Ewart and Son, Limited, London.
12,891. REVERSIBLE TRAM SEATS, D. C. Williamson, Manchester.
12,892. CHAIR WHEEL ARRANGEMENT, J. Adair, Waterford, Ireland.
12,893. HANDLES for CABINETS, T. A. Smith, Birmingham.
12,894. LUBRICATORS, J. W. Milligan and J. Clemont, Birmingham.
12,895. GRAVITATION ENGINE, A. Cummings and J. Randes, Peterborough.
12,896. PIPE JOINTS, J. Coulthurst, Manchester.
12,897. STRENGTHENING ENDS of TUBES, J. Holden, Manchester.
12,898. RINGING CYCLE BELLS, J. H. Janson, Stockton-on-Tees.
12,899. HOLDERS for BALLS of STRING, A. E. Milton, Birmingham.
12,900. PRESSES, H. Woodhead, jun., Leeds.
12,901. FINISHING TEXTILE FABRICS, C. Wood, Stockport.
12,902. SEWING MACHINE GUIDE, J. K. Macdonald.—(*The Singer Manufacturing Company, United States.*)
12,903. TAKE-UP DEVICE for SEWING MACHINES, J. K. Macdonald.—(*The Singer Manufacturing Company, United States.*)
12,904. ATTACHMENT HOLDER for SEWING MACHINES, J. K. Macdonald.—(*The Singer Manufacturing Company, United States.*)
12,905. RUFFLERS for SEWING MACHINES, J. K. Macdonald.—(*The Singer Manufacturing Company, United States.*)
12,906. PURLING DEVICE for SEWING MACHINES, J. K. Macdonald.—(*The Singer Manufacturing Company, United States.*)
12,907. TUCK CREASERS for SEWING MACHINES, J. K. Macdonald.—(*The Singer Manufacturing Company, United States.*)
12,908. REMOVING SCRAP from CHAIN LINKS, A. G. Strathern, Glasgow.
12,909. SEPARATING LINKS of CHAINS, A. G. Strathern, Glasgow.
12,910. RAILWAY SWITCH BOXES, G. Urie and W. Gillespie, Glasgow.
12,911. PRODUCTION of TOBACCO PIPES, T. D. Young, Glasgow.
12,912. LOCKS, G. Downes, Manchester.
12,913. TRAMCAR BRAKE, J. Greenhalgh and J. Slack, Manchester.
12,914. KNIFE HANDLES, E. Priestman and F. Thornhill, Sheffield.
12,915. MAKING CARBON DI-OXIDE GAS, J. Aldred, Manchester.
12,916. MANUFACTURE of TOILET SOAP, E. Leon, Salford.
12,917. COTS, L. H. and S. H. Brierley and J. Pitt, Birmingham.
12,918. GASIFICATION of FUEL, W. Young and S. and T. Glover, Peebles, N.B.
12,919. BICYCLES DRIVEN by HANDS or FEET, T. F. Walsh, Stafford.
12,920. HOLLOW INTERLOCKING BLOCKS, J. G. Forbes, Glasgow.
12,921. TOY PISTOL, J. H. Johnson, Swindon.
12,922. LAMP, M. A. Hartmann, Berlin.
12,923. ROLLER BEARINGS, J. W. Bowley, Manchester.
12,924. HORSE HOOD, W. L. Orpwood, Oxford.
12,925. SAFETY HOOK for BAGS and PURSES, B. Bloom, London.
12,926. BOTTLE, M. F. Jones, London.
12,927. ORGANS, G. F. Smith, London.
12,928. VIOLIN BOW, A. Diehl, London.
12,929. UTILISING MOTOR CAR POWER, H. M. Salmony, London.
12,930. RIMERS, G. Shaw, Belfast.
12,931. BRAIDS and LACES, H. Stommel, Barmen, Germany.
12,932. POURING-OUT LIQUIDS, W. Schmitt, Barmen, Germany.
12,933. GAS-BOILING STOVES, W. Krefft, Barmen, Germany.
12,934. COMBINED SEAT and STAND, H. A. Barnes, London.
12,935. COUPLING MECHANISM, O. Imray.—(*J. Willison, Germany.*)
12,936. CONSTRUCTING HAND CASES for BOOKS, J. Geer, London.
12,937. DRILLS, B. Winch, London.
12,938. CHARGING DESTRUCTOR FURNACES, G. Watson, London.
12,939. CONTROLLING FLOW of LIQUIDS, H. Marcus, London.
12,940. COMBATING SCABIES, P. Bachmann, Cologne, Germany.
12,941. STOPPING or SLOWING-DOWN TRAINS, J. A. Guerin, London.
12,942. SMOKE-CONSUMING APPARATUS, A. R. Scherding, London.
12,943. FILTERS, H. Hencke, London.
12,944. HEATING STEAM, W. G. Hollingworth and W. Clowes, London.
12,945. PROPELLERS and STEERING APPARATUS, V. Sjöström, London.
12,946. RAILWAY CROSSINGS, E. M. Rankin, London.
12,947. TOOL-HOLDERS, G. A. Cuccotti and W. K.-L. Dickson, London.
12,948. RAIL FASTENINGS for RAILWAYS, W. C. Somerville, London.
12,949. MAKING HOLLOW RIVETS or EYELETS, T. Remus, London.
12,950. RETAINING HAT RAILS in POSITION, J. C. Webb, London.
12,951. SWITCHES, O. Schwimmer, I. Schön, and M. B. Schwimmer, London.
12,952. KILNS, A. von Elefánty, London.
12,953. BRAIDING MACHINES, B. Kirsch and A. Pessl, London.
12,954. FIXING HANDLES to BROOMS, A. Woollen, London.
12,955. SUSPENDED GAS HEATING-STOVE, H. Junkers, London.
12,956. TELEGRAPH TRANSMITTING APPARATUS, P. M. Justice.—(*The Rowland Telegraphic Company, United States.*)
12,957. MAKING FATTY SUBSTANCES, O. Liebreich, London.
12,958. SWITCHES, H. H. Lake.—(*General Electric Company, United States.*)
12,959. WINDING TAPE on COILS of ELECTRICAL APPARATUS, H. H. Lake.—(*General Electric Company, United States.*)
12,960. ELECTRICAL CONDUCTORS, H. H. Lake.—(*General Electric Company, United States.*)
12,961. TIME-RECORDING MECHANISM, W. H. Bundy, London.
12,962. PROTECTORS for SOLES of CLOGS, S. Turton, London.
12,963. CURTAIN-FASTENING DEVICE, F. A. Vorwerk, London.
12,964. PREVENTING REFILLING of BOTTLES, H. Iliff, London.
12,965. MECHANICAL DRAWING APPLIANCES, D. A. Low, London.
12,966. CONVEYORS, M. Bradfield and J. M. Kellerman, London.
12,967. COUPLING, W. P. Thompson.—(*T. H. Simpson, United States.*)
12,968. BELTS, J. J. Ridgway, Liverpool.
12,969. KNURLING MACHINES, A. J. Boult.—(*United Shoe Machinery Company, United States.*)
12,970. KNURLING MACHINES, A. J. Boult.—(*United Shoe Machinery Company, United States.*)
12,971. DRIVING DEVICES for AUTOMOBILES, M. A. Eudelin, London.
12,972. BOXES, G. Migliardi, London.
12,973. PHOTOGRAPHIC APPARATUS, C. A. Mercier, London.
12,974. SECURING PACKING CASES, W. T. Muggli, London.
12,975. PLIERS, A. A. Kraeuter, London.

7th June, 1902.

12,976. FLY CATCHER, A. Creasy, Great Bentley, Essex.
12,977. PERPETUAL MOTION MACHINE, E. J. Coombe, Minehead, Somerset.
12,978. LAMP GLASSES, O. Schott, Jena, Germany.
12,979. WATER-CLOSETS, J. Shanks, Glasgow.
12,980. BOTTLES for AERATING LIQUIDS, S. J. Cairns, Belfast.
12,981. SPINNING and TWISTING FRAMES, H. Carter, Belfast.
12,982. DRY SEAT for STREET CARS, D. B. Smaill, Edinburgh.
12,983. BICYCLES and TRICYCLES, G. Wilkins, Erith, Kent.
12,984. APPLYING MOTIVE POWER, R. Paulson, Hove, Sussex.
12,985. METHOD of PROPELLING SHIPS, F. W. Jones, London.
12,986. BOILERS, G. MacC. Brand, Glasgow.
12,987. ROUTE INDICATORS for TRAMCARS, A. S. Giles, Halifax.
12,988. BOOTS and SHOES, J. Rangeley, Huddersfield

12,989. DYEING FIBROUS MATERIALS, A. H. Graemiger, Manchester.
12,990. WHEEL GUARDS for TRAMCARS, J. Hubbard, Hull.
12,991. STOCK or PLATE LOCKS for DOORS, P. Mountford, Birmingham.
12,992. DEVICE for SUSPENDING SLINGS, A. Hynd, Glasgow.
12,993. MACHINES for BOTTLING, C. Chambers, Birmingham.
12,994. AIR SPRING for BICYCLES, &c., H. Egloff, London.
12,995. CONCENTRATION of ORES, A. R. Robertson, Glasgow.
12,996. PRINTING, London Colour Printing Company, Limited, London.
12,997. WEATHER COVERS for TRAMCARS, J. Griffiths, Manchester.
12,998. WEATHER WINDOWS for TRAMCARS, J. Griffiths, Manchester.
12,999. WEATHER FRAMES for TRAMCARS, J. Griffiths, Manchester.
13,000. GRINDING BALLS, J. G. Liversidge, sen., and J. G. Liversidge, jun., Leeds.
13,001. TRAMCARS, J. A. de Macedo, Leeds.
13,002. OUTDOOR SEAT, J. Smith and E. Langton, Manchester.
13,003. ROCK-DISINTEGRATING PROCESS, A. Gutensohn, London.
13,004. LEAD ORE-TREATING PROCESS, A. Gutensohn, London.
13,005. PORTABLE BUILDINGS, W. Calway, Gloucester.
13,006. LOCK NUT, P. E. Lill, London.
13,007. GAS-COOKING GRILLERS, H. N. Davis, London.
13,008. COMBINED KIT-BOX, &c., W. W. W. Green, London.
13,009. LETTER-BOXES, F. Marx and E. Merei, London.
13,010. BOXES for GOLF-PUTTING HOLES, A. Cole, London.
13,011. BUTTER-MOULDING DEVICES, F. A. Wegner, London.
13,012. CULTIVATORS, T. D. Terry, London.
13,013. BOTTLE STOPPERS, L. Boucay, London.
13,014. PUDDING MOULD, M. Potter, London.
13,015. DARNING, F. White, London.
13,016. ATTACHING PLACQUETS to EYEGLASSES, L. Laurance, London.
13,017. ADJUSTING CHAIR HEAD-RESTS, C. Medcalf, London.
13,018. ATTACHING TRAILERS to CYCLES, W. F. French, London.
13,019. TOY, G. Webb, London.
13,020. DAMPING GUMMED SURFACES, J. M. Herring, London.
13,021. MOTOR ACTUATED by WATER, T. A. Crossgrove, London.
13,022. STEAM GENERATORS, A. Hughes, London.
13,023. COATING METAL-CASTING MOULDS, H. Stanning, London.
13,024. LIQUID-DELIVERING APPARATUS, A. B. Jackson, London.
13,025. MAKING ALUMINIUM, P. Jensen.—(*W. Rübel, Germany.*)
13,026. REDUCING the QUANTITY of LIQUID to be EVAPORATED, V. F. Feeny.—(*The Abwärme Kraftmaschinen-Gesellschaft m. b. H., Germany.*)
13,027. VEGETABLE PRODUCTS, W. M. Williams and F. Hutchins, London.
13,028. IRONING MACHINE TABLE, T. and C. W. Hall, London.
13,029. METALLIC BAND for CLOSING TINS, F. Ginet, Liverpool.
13,030. FUEL REGULATOR for BOILERS, P. G. A. Peugeot, London.
13,031. HYDRAULIC AIR COMPRESSORS, C. H. Taylor, London.
13,032. CARRIAGE HUBS, W. Hillman, London.
13,033. ANTI-FRICTION BEARINGS, W. Hillman, London.
13,034. SANITARY TOWELS, T. Barclay, sen., and T. Barclay, jun., London.
13,035. STEAM GENERATORS, T. H. Bethell and D. J. Smith, London.
13,036. VAPORISERS, T. H. Bethell and D. J. Smith, London.
13,037. COIN-FREED ELECTRICITY MACHINE, J. Jofeh, London.
13,038. SUCTION PUMPS, R. J. Brooks, Belfast.
13,039. PREVENTING WETTING of CLOTHING, H. Cox London.
13,040. LUBRICATING DEVICES, H. H. Lake.—(*Vereinigte Maschinenfabrik Augsburg und Maschinenbaugesellschaft Nürnberg A.-G., Germany.*)
13,041. DIVIDING and MEASURING MACHINE, H. D. Wilson, London.
13,042. PUMPS, H. H. Lake.—(*Vereinigte Maschinenfabrik Augsburg und Maschinenbaugesellschaft Nürnberg A.-G., Germany.*)
13,043. CENTRIFUGAL GOVERNORS, A. S. F. Robinson, London.
13,044. PROJECTILES and ACCESSORIES, E. R. Calthrop, London.

9th June, 1902.

13,045. FIRE-GUARDS, A. Bunch, Birmingham.
13,046. AUTOMATIC DELIVERY APPARATUS, E. R. S. Bartlett and W. Sealey, Birmingham.
13,047. VAPOUR BATHS, W. Waddington and W. Wainhouse, York.
13,048. PROPULSION of SHIPS, G. Gibson and J. Byrne, London.
13,049. PROPELLERS, T. Sheppardson and D. McNeil, West Hartlepool.
13,050. CHAIRS, W. S. McLennan, Glasgow.
13,051. MUD-GUARDS for MOTOR VEHICLES, E. Carver, Coventry.
13,052. SPRING FASTENERS, C. A. Pfenning, Manchester.
13,053. BOOT BRUSH CASE, F. G. Smith, Windsor.
13,054. FEEDING PAPER to PRINTING MACHINES, J. Bennett and R. Tottey, Stafford.
13,055. GAS ENGINES, A. Rollason, Long Eaton, Derbyshire.
13,056. DISTRIBUTING ICE CREAM, A. A. Wade, Leeds.
13,057. COOKING RANGES, A. and W. R. Neil, and Fletcher, Russell and Co., Limited, Manchester.
13,058. GAS COOKING RANGES, A. and W. R. Neil, and Fletcher, Russell and Co., Limited, Manchester.
13,059. COOKING RANGES, A. and W. R. Neil, and Fletcher, Russell and Co., Limited, Manchester.
13,060. DOBBIES of LOOMS for WEAVING, J. Ward, Halifax.
13,061. PHOTOGRAPHIC OBJECTIVES, P. Rudolph, Jena, Germany.
13,062. EXTENSION TABLES, D. Pogson, Manchester.
13,063. METAL STAMPING MACHINES, C. C. Black, Glasgow.
13,064. ELECTRIC FIRE ALARM, R. W. Cooke and J. Scott, Newcastle-upon-Tyne.
13,065. PROPELLING MECHANISM of TORPEDOES, F. W. Dodd, Weymouth.
13,066. POLO STICK, W. J. Hunt-Grubbe, Isle of Wight.
13,067. PHONOGRAPHS, W. E. Heys.—(*La Compagnie Générale des Phonographes, Cinématographes et Appareils de Précision, France.*)
13,068. The "QUEEN" WRISTLET, S. Markiewicz, London.
13,069. MIRROR PHOTOGRAPHIC GLASSES, A. Quarterman, London.
13,070. AUGER GUIDES, S. R. Dummer, jun., New York City.
13,071. HOE, E. O. Adcock, Norwich.
13,072. PORTABLE NIGHT COMMODES, G. Clark, London.
13,073. RIFLES and SMALL ARMS, J. B. Thorneycroft, Glasgow.
13,074. ELECTRIC HEATING APPARATUS, F. Tomlin, London.
13,075. CHUCKS, F. A. Errington, London.
13,076. FUEL ECONOMISER, M. J. Darg, Croydon, Surrey.
13,077. ELASTIC TIRES of WHEELS, J. A. Mays, London.
13,078. SAND DISTRIBUTING MACHINE, N. F. Galafre, London.
13,079. COMPOUNDS of PHOSPHORUS and SULPHUR, E. W. Wheelwright and R. Threlfall, London.
13,080. UMBRELLA CARRYING DEVICE, M. G. Jolley, London.
13,081. PNEUMATIC TIRE PROTECTOR, I. Clifford, London.
13,082. ELECTRICAL SWITCH, M. Railing and J. H. Collings, London.
13,083. MOVEMENT for SCREENS, &c., C. Ehrhard, London.
13,084. FIXING MEDIUM for DENTISTS, A. Masur, London.
13,085. PUMPING ENGINES, H. E. Newton.—(*H. B. Worthington, United States.*)
13,086. GAS ARC LAMPS, J. K. Russell and W. F. Clausen, London.
13,087. VALVE APPARATUS, P. F. Oddie, London.
13,088. ELECTRIC ARC LAMPS, R. Hopfelt, London.
13,089. ATOMISERS, A. M. Clark.—(*Whitall Tatum Company, United States.*)
13,090. FOOTBALL BOOTS, A. R. L. Smith, H. and J. Maufield, and C. L. Braillard, London.
13,091. ROTARY MOTORS, W. L. Wise.—(*W. P. Churchward, Italy.*)
13,092. TYPE-SETTING MACHINES, H. B. Bartlett, London.
13,093. TRANSFER PICTURES, R. Krayn, London.
13,094. WATER LEVEL INDICATOR, F. Paul, Liverpool.
13,095. CUFF FASTENERS, H. French London.
13,096. MONEY BOXES, J. Kahn and W. Stranders, London.
13,097. BALL MILLS, C. G. Redfern.—(*Commercienrath Gotthard Sachsenberg, Germany.*)
13,098. BICYCLE BRAKES and COASTERS, S. King, London.
13,099. FLUSHING CISTERNS, T. Smith and J. W. Molden, London.
13,100. MUSICAL INSTRUMENT DEVICES, H. E. Sharps, London.
13,101. PNEUMATIC HOISTS, R. W. James.—(*The Pedrick and Ayer Company, United States.*)
13,102. RAZORS, W. Schuch and H. D. Schutte, London.
13,103. AUTOMATIC SPRINKLERS, W. Morgan, London.
13,104. COMBUSTIBLE VAPOURS, J. Imbert and A. Morel, London.
13,105. CAR TRUCKS, J. Timms, London.
13,106. CAR TRUCKS, J. Timms, London.
13,107. DOOR CLOSERS, H. J. Haddan.—(*C. Seikat, Germany.*)
13,108. DETACHABLE TOOL HOLDERS, S. S. Swan, London.
13,109 BLOCKS for AXLES, J. H. Monbeig and P. Forrans, London.
13,110. LUBRICATORS, E. Allen and G. W. Carver, London.
13,111. EXPLOSIVES, J. M. Az, London.
13,112. ENDLESS STRIPS of STRING, R. Kron, jun., London.
13,113. APPARATUS for HEATING LIQUIDS, H. Junkers, London.
13,114. FURNACES, C. Leistner, London.
13,115. WIRELESS TELEGRAPHY, J. H. Thomson, London.
13,116. EVAPORATOR, V. F. Feeny.—(*The Abwärme-Kraftmaschinen-Gesellschaft m. b. H., Germany.*)
13,117. BOOT-FINISHING MACHINES, H. G. Waghorn, London.
13,118. STAINING of TIMBER, M. Grünhut, London.
13,119. ELECTRICAL TESTING APPARATUS, D. Perret, London.
13,120. COMPRESSING COAL, F. and F. Méguin and Co., Actien-Gesellschaft, London.
13,121. BLEACHING THREAD, A. J. Boult.—(*A. Vogelsang, Germany.*)
13,122. TYPE MOULDS, H. M. Duncan and F. H. Pierpont, London.
13,123. PRINTING PRESSES, H. W. Morgan, London.
13,124. CRANES, W. S. Boult, London.
13,125. GLOVES, E. D. Raymond, Stoke-under-Ham, Somerset.

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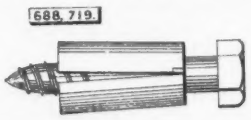
13,126. ROTARY ENGINES, H. H. Hodgson, Leeds.
13,127. STOPPERS for BOTTLES, A. W. Mackenzie, Edinburgh.
13,128. DUST EXCLUDER for DOORS, C. J. Connock, Eastleigh, Hants.
13,129. DISPLAYING ILLUMINATED DESIGNS, T. Redman, Keighley.
13,130. DEVICE for HEATING CHARCOAL, J. W. Hall, Keighley.
13,131. LIGHT PROJECTING APPARATUS, J. A. and W. T. Purves, Edinburgh.
13,132. HOOKS for FASTENING LADIES' CLOTHING, M. E. Fulton, Glasgow.
13,133. FOUNTAIN PENS, G. W. Perks and F. C. Thacker, Birmingham.
13,134. TYPE-WRITING MACHINE, H. B. Stocks and F. Foster, Manchester.
13,135. LOCKS, F. Smith, Birmingham.
13,136. FASTENINGS for LAVATORIES, A. Illidge, Brewood, Stafford.
13,137. SPEED-RECORDING APPARATUS, A. S. Giles, Halifax.
13,138. PLANT POTS, F. James, Manchester.
13,139. MUSIC STOOLS, W. S. McLennan, Glasgow.
13,140. PLANTING POTATOES, J. Boardmann, Rainford, near St. Helens.
13,141. STREET RAILWAY POINTS, A. H. Gibbings, Liverpool.
13,142. PRODUCTION of BLACK COLOURING MATTER, A. Ashworth, Bury, Lancs.
13,143. PUFF VALVE, G. Park, Glasgow.
13,144. INCANDESCENT LAMPS, J. and G. Keith, Glasgow.
13,145. PERFORMING IRREGULAR TURNERY, R. A. M. Menzies, Leith.
13,146. COMBINED BATH and LAVATORY BASIN, M. J. Adams, Leeds.
13,147. CIGARETTE CASE and MATCH-BOX, A. E. Drew, Bolton.
13,148. FOUNTAIN PENS, A. and L. Myers and F. R. Baker, Birmingham.
13,149. ACETYLENE GAS GENERATORS, R. Cumming, Glasgow.
13,150. STARTING CRYSTALLISATION in THERMOPHONES, F. Heiliger, Liverpool.
13,151. CHIPPING TOOLS, H. McClenahan, Liverpool.
13,152. DRYING OSTRICH FEATHERS, J. Bowie, Glasgow.
13,153. MANUFACTURE of CYCLE SADDLES, E. Lycett, Birmingham.
13,154. ELECTRO-MAGNETIC ANNUNCIATORS, H. Oppenheimer.—(*Actien-Gesellschaft Mix and Genest, Germany.*)
13,155. TRANSMITTING SIGHT by MAGNETIC PULSES, C. J. Pepper, London.
13,156. REMOVING ROAD SWEEPINGS, W. W. Foster, London.
13,157. LOOMS, A. G. Brookes.—(*Northrop Loom Company, United States.*)
13,158 DEPOSITING FUMES from ORES, W. W. Fyfe, London.
13,159. DRIVING MECHANISM, G. T. Hyde.—(*A. N. Benjamin, United States.*)
13,160. FASTENERS for PORTMANTEAUS, L. Meyer, London.
13,161. REVERSING GEAR, W. Radford and E. Gifford, London.
13,162. TROWEL HOE, J. L. H. Johnstone, Bradford-on-Avon.
13,163. PUNCTURE-PROOF TIRE, G. H. Hastings, London.
13,164. LIGHTING of TRAINS, H. Leitner and R. N. Lucas, London.
13,165. PREPARATION of SICCATIVE OILS, W. B. Cowell, London.
13,166. SPINNING FIBRES, J. Dyson and G. A. Burnett, London.
13,167. MEANS for AERATING BEER, E. C. Harvey, London.
13,168. PEDAL CRANK for VELOCIPEDES, T. Bass, London.
13,169. PNEUMATIC HAMMERS, The International Pneumatic Tool Company, Limited, and T. Bergstrom, London.
13,170. TROLLEY WIRE SUPPORT, E. and E. Hill, jun., London.
13,171. TROLLEY WIRE SUPPORT, E. and E. Hill, jun., London.
13,172. PLAYING MUSICAL INSTRUMENTS, H. H. Lake.—(*The Æolian Company, United States.*)

SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

688,719. BOLT ANCHOR, *J. H. Cook, New York, N. Y.*—*Filed October 29th*, 1901.

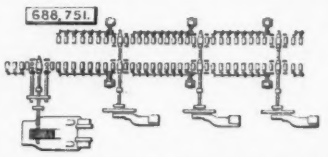
Claim.—A bolt anchor comprising two similar shields of substantially semicylindrical form, said shields being provided with ribs and with aligning lugs and grooves, said shields being formed with a threaded bolt hole shallower at the rear of the shields than at



the head of the same, said bolt hole being symmetrically placed in the head of the shields and being unsymmetrically placed in the rear of the shields to form oppositely projecting gripping wings when a bolt is inserted into the said bolt hole.

688,751. ROLLING MILL, *J. Stevenson, Jr., Sharon, Pa.*—*Filed June 5th*, 1901.

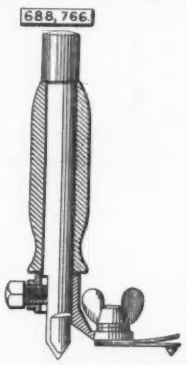
Claim.—(1) A rolling mill comprising a reversing universal mill having sets o vertical rolls on both sides of the horizontal rolls and a set of plain-faced



two-high rolls arranged to receive the metal therefrom, and in line with said universal mill, substantially as described. (2) A rolling mill comprising a reversing universal mill, having sets of vertical rolls on both sides of the horizontal rolls and two lines of plain-faced two-high rolls arranged to receive the metal therefrom, one of said lines being arranged in tandem with the universal mill, substantially as described.

688,766. TOOL FOR CENTERING DRILLS, *L. Williams, Johnstown, Pa.*—*Filed September 7th*, 1901.

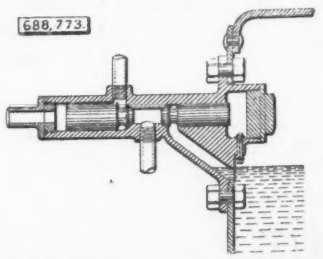
Claim.—(1) A marking tool for laying out points on a circle as described, consisting essentially of a centering point, and a centre punch supported on an arm in adjustable relation to said centering point. (2) The



tool described, consisting essentially of a centering point carried by a bar, and a spring-supported centre punch carried by a handle and in adjustable relation to said point. (3) In a tool as described, the punch having a head, a socket removably secured to the body of the punch, and a swivelled handle interposed, a rigid arm on the socket, and a bar provided with a centering point held to said arm by a clamping pivot, all combined.

688,773. FEED REGULATOR FOR BOILERS, *W. H. Edmondson, Worcester, Mass.*—*Filed March 26th*, 1900.

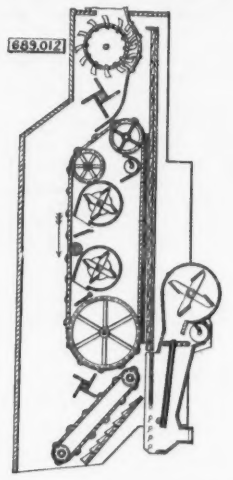
Claim.—The combination of a boiler and a feed regulator, comprising a casing 10 having a controlling chamber extending into the boiler space, and having a contracted connection therewith, a piston 14 movable into the controlling chamber, and carrying a feed



valve 15, and a larger piston 18 carrying a waste valve 19, boiler pressure being admitted to the outer end of the casing to act directly on the piston 18, whereby it normally requires more pressure to open the waste valve than the feed valve, and whereby the presence of liquid in the controlling chamber will prevent the pressure of a pulsating supply from opening the feed valve, substantially as described.

689,012. THRESHING MACHINE, *J. Lindner, Waconia, Minn.*—*Filed April 2nd*, 1901.

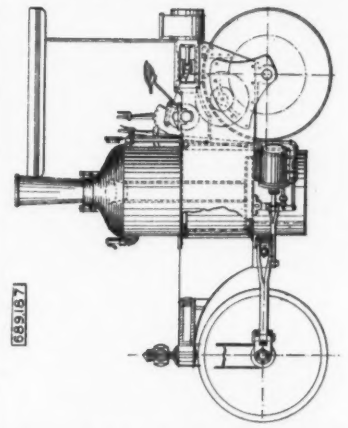
Claim.—(1) The combination of a threshing mechanism, an endless travelling carrier comprising flexible endless elements, pulleys on which they operate and cross slats connecting said flexible endless elements, a straw ejector disposed within said carrier, above the lower lead thereof, and means operated by said carrier, to throw the straw, from said lower lead of said carrier on to said straw ejector, substantially as described. (2) In combination with an endless travelling carrier of the class described, a straw-ejecting worm disposed within said carrier above the lower lead thereof and beaters to throw the straw from the lower lead of said carrier on to said straw-ejecting worm, substantially as described. (3) An endless travelling straw carrier of



the class described, comprising a plurality of carrier ropes spaced apart, couplings connecting the ends of said respective carrier ropes, each of said couplings comprising a pair of sections adjustably secured on the ends of one of said ropes and flexibly connected together, cross slats connecting said carrier ropes, supporting shafts and pulleys on said shafts, and having peripheral grooves engaged by said carrier ropes, substantially as described.

689,187. STEAM ROAD ROLLER, *C. L. Heisler, Erie, Pa.*—*Filed November 20th*, 1899.

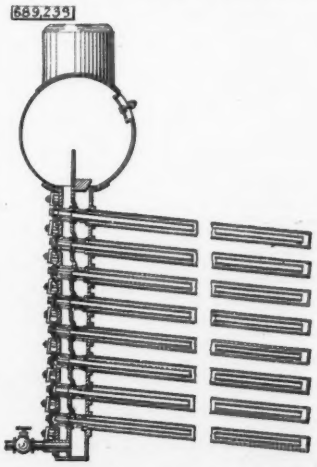
Claim.—(1) In a road roller, the combination of a frame, comprising two main side pieces arranged in the form of a gooseneck at the front end, and having the extended rear plates, a connection 21 for the rear end of the sides of the frame, the front and rear rollers supporting the frame, a water tank arranged in the gooseneck and comprising a part of the frame within its walls, an engine arranged on the cross-piece 21, a



gearing connected in said engine with the rear roll, and an upright boiler arranged between the side pieces and between the rolls. (2) In a road roller, the combination with a frame, a front roller arranged to swing on said frame, a beam 7 pivoted on said frame, links for transmitting the motion of the beam to the roller, a cylinder, an upright boiler suspended in said frame immediately to the rear of said beam, a piston arranged to operate in said cylinder, connections between said piston and said beam, and a valve device for controlling said piston.

689,239. BOILER, *J. P. Sneddon, Barberton, Ohio.*—*Filed April 12th*, 1901.

Claim.—(1) In a boiler having inner and outer water tubes communicating respectively with a downtake and an uptake compartment or passage, an outlet communicating with the lower end of one of said compartments or passages, and means for closing the upper end of the same compartment or passage. (2) In a boiler having inner and outer water



tubes communicating respectively with a downtake and an uptake compartment, an outlet communicating with the lower end of the uptake compartment, and means for closing the upper end of said compartment. (3) In a boiler having inner and outer water tubes communicating respectively with a downtake and an uptake compartment or passage, an outlet communicating with the lower end of the uptake compartment, and a plug for closing the upper end of said compartment or passage.

ELECTRICITY AND LEGISLATION.

No. III.*

IN our second article on June 13th we dealt with the municipal side of the question as set forth in the evidence of Alderman Ivey and Alderman Pearson. We now return to the opinions and facts supplied by the electrical engineers.

Mr. Percy Sellon, chairman of the Electrical Trade Section of the London Chamber of Commerce, while willing to admit that legislation has been adverse to the progress of electrical engineering in this country, appears to hold that this adverse legislation was in a measure inevitable, and that it was out of the power of any body of men to prevent it. It arose in the conditions prevailing. The growth of the factory system, and the increasing burthen of legislative detail which Parliament was called upon to bear, led to a policy of decentralisation, which first found expression in the Municipal Corporations Act of 1834. By degrees, water supply, gas, tramways, markets, &c., have been municipalised.

When, therefore, practical possibilities in the way of electric lighting and power appeared upon the scene through the almost simultaneous commercial development of the dynamo machine and arc and incandescent light, at the end of the seventies, the public mind was ripe for treating them on the approved lines of collectivism; and in framing the Electric Lighting Act, 1882, the Legislature was guided by a prominent advocate of this policy, namely, Mr. Joseph Chamberlain, then President of the Board of Trade. When electric traction made its appearance a few years later it found itself subject to the same influence in the shape of the Tramways Act of 1870.

Mr. Sellon went on to say that a great mistake was made in applying the principle of municipilisation to an undeveloped industry. Corporations are not adapted to the work of developing inventions, and the industry has suffered in consequence.

Broadly speaking, two results have flowed from the policy of giving local authorities the prior right to undertake electricity supply within their areas, namely:—

(*a*) Numerous local authorities have used their power either to block or to hang up the introduction of electricity supply within their boundaries. Of some three hundred Provisional Orders granted to local authorities, only about one-third have been put into force.

(*b*) Where, on the other hand, local authorities have been willing to consent to the introduction of electricity supply by private capital, the conditions imposed by electrical legislation have afforded insufficient inducement to investors to find capital for such enterprises.

The backwardness of electricity supply and traction undertakings has in turn reacted upon the electrical manufacturing industry in Great Britain, with the result that British manufacturers are largely unable to meet either the requirements of the home or of foreign markets.

Mr. Sellon holds that the Institution of Electrical Engineers is to blame because it has ignored the commercial and industrial progress of electricity, and he suggests that the Institution should frankly recognise its position and take steps (1) to create an organisation from its own body, and representatives of Chambers of Commerce and other influential bodies and persons, for the purpose of safeguarding the welfare of the industry; (2) make representations to the Government, either directly or through the State departments concerned, that (*a*) such organisation should receive recognition and a locus in questions of electrical legislation and regulations; (*b*) amendment of existing legislation, particularly that relating to electric traction, is urgently necessary; (*c*) the future relations of local authorities towards electrical enterprise should be defined by Parliament.

Mr. Campbell Swinton was the next witness examined. Speaking of legislation, he made use of words almost identical with those which we also have used some time since. We have said that all legislation has been in its nature prohibitive. The manufacturer is continually told that he must not do such and such things. Mr. Swinton points out that legislation has always been "restrictive, never enabling." The prime error has been the giving to municipal authorities a priority over private enterprise. Municipalities must not speculate with the ratepayers' money; consequently they cannot embark upon new enterprises until others have shown that these enterprises are non-speculative. In other words, municipalities cannot take risks that may legitimately be taken by private enterprise. The priority given to municipalities has therefore inevitably led to a much slower rate of progress in electrical application than would have resulted had private enterprise had free scope. This had reacted upon electrical manufacturing, with the result that our electrical manufactories are on a smaller scale, and have not had the chance of obtaining either as much employment for capital or as much experience as our foreign competitors. Here we have the keynote of Mr. Swinton's evidence. After going into details in support of his contention, he went on to say that the remedy for the existing state of affairs is, in his opinion, persistent and organised agitation. Among matters to be dealt with he suggests:—(*a*) The constitution of a special Standing Committee of the Institution, whom the Board of Trade should be bound to consult upon all matters affecting the electrical industry; (*b*) the constitution of a special electrical department of the Board of Trade, with a sufficient number of officials chosen for their knowledge of the subject to deal with electrical matters on broad and comprehensive lines; (*c*) an alteration, to be both prospective and retrospective, in the purchase clause of the Electric Lighting and Tramway Acts whereby companies whose undertakings are purchased by local authorities should be safeguarded against loss of capital; (*d*) changes in parliamentary procedure whereby the great cost of obtaining parliamentary powers shall be reduced, and whereby the direct pecuniary incentives that at present are a temptation to the officials of local authorities to oppose all private Bills that affect their district shall be removed; (*e*) modification of the veto of local authorities, and in the case of tramways, of frontagers, and the removal of legislative restriction upon electrical enterprise generally.

* No. II. appeared June 13th.

The questions put to Mr. Swinton, mainly by Mr. Mordey, were directed to obtain information concerning the commercial position of the manufacturing electricians of the United States and of Germany. The general drift of the replies was that trade had been carried on at a considerable loss in the United States and in Germany. The questions put to the witnesses were intended to elicit an expression of opinion on two points: Was the lavish expenditure that took place in a sense justifiable, because although it was far from being directly remunerative, it promoted the development of an industry certain to be ultimately remunerative; and, secondly, that, after all, English manufacturers were justified in proceeding with caution, because they thereby escaped loss. His reply to the first question was in the main affirmative. His reply to the second was qualified. He held that the circumstances should never have arisen which rendered caution necessary. If private enterprise had been given free play, as it had in other countries, then electrical engineering would have been as fully developed in Great Britain as in any other part of the world. It will be seen that the first question raises a very important issue. Germany, for example, has spent far more money than she could spare in developing certain industries, notably the machine tool trade and electric lighting and power. The result has, for the time being, been disastrous. Forced sales of all manner of products have taken place; yet the transaction, taken as a whole, has no doubt developed machinery to a surprising extent, and in the end the country may be very much better off than it would have been if no speculation had taken place. On the one hand, we have had Great Britain moving with great caution, very slowly, fearing a fall; on the other hand, we have a nation borne on a hurricane of energy, stumbling, falling, beaten, and yet reaching the goal long before a plodding competitor. The critic may censure Great Britain, but he must not forget how heavy has been the price paid in Germany in achieving a supremacy which cannot last. To use words we once heard uttered by an eminent American speaker, "England may be slow, but she is dreadful sure." Yet we must bear always in mind that, while the national policy remains as it is, it is out of the question to expect electrical science or industry to advance with the rapidity attending its progress in countries where men are not less able and enjoy far more freedom than electrical engineers in this country.

Dr. Spence Watson's evidence followed that of Mr. Swinton. He advanced three specific points as follows:—First, that the entrusting of large electrical undertakings to municipal bodies is by no means always attended with benefit to the public; secondly, that requiring the consents of local authorities in relation to special Acts for tramways as a condition precedent to such Acts being considered on their merits has in some cases an unfair tendency, and is prejudicial to the public interests; thirdly, that the powers given to local authorities of interference in electrical matters can be exercised to the prejudice of the manufacturing interests of the country, and therefore of all classes alike, but especially of the working classes. He illustrated these propositions by the story of the Newcastle-on-Tyne and the Gateshead tramways, and this story is so interesting that we conclude this article by reproducing it in full.

The first point is the entrusting of large electrical undertakings to municipal bodies, which, I say, is by no means always attended with benefit to the public. I illustrate that by the history of the Newcastle trams. We have had a good deal of experience lately of the trams in Newcastle undertaken by the Newcastle Corporation, and the trams made across the river at Gateshead by the Gateshead and District Tramways Company. They have both been going on at the same time. I do not wish to go into any statement as to the time taken up in the construction of these lines, because there are so many things which enter into that question. But, as to actual costs, the first estimate for the cost of the Corporation trams in Newcastle—40½ miles actual, 20¼ route miles, of which up to the present they have constructed four-fifths—was £400,000. They have cost up to the present time nearly a million; but it is difficult to say precisely where the excess arises, because the special generating station built by the Corporation has cost a very large amount, and there are two different statements authoritatively made, one as to the extra cost of the lines and electrical equipment, and another as to that of the generating station. We may take into consideration the generating station first. The Corporation generating station, and that which the Newcastle-upon-Tyne Electric Supply Company have been building at Wallsend, were begun both about the same time. Both had to contend with similar difficulties, including a great strike in the building trade. The Wallsend generating station was built in less than twelve months, and has since then been so extended that it already contains double the power of the Newcastle station; while that of the Newcastle Corporation has taken two years to build, and is only just open. Passing to the track, the only absolute figure I can get as to the cost per mile of the lines of single track of the Newcastle Corporation is their estimate for certain great extensions which they are proposing at the present time in the surrounding country. They obtained powers in 1899 to make trams in Newcastle, and about half of those trams have now been open for a week or ten days. They are proposing now to go into the surrounding country and spend some £400,000 in new trams outside their district. They make an actual estimate that the single track, including electrical equipment, is to cost £12,800 a mile. The Gateshead Company's trams, including electrical equipment, have cost about £7000 a mile, and the Tyneside Company's trams, which are now let and about to be begun, will be under £7000 a mile. My point here is, that at all events in the first cost it by no means necessarily follows that a municipal body can get better results than a company. Really what I believe to be the case, and what I point out in the proof of my evidence here, is that, although no doubt they do them very substantially, the fact that the city funds are behind them must always have a tendency to make the municipal authorities a little more—if I may use the term—reckless in their work than is the case with a private company, where there is a body of shareholders to be directly accounted with. The second point in my proof is upon the consents of local authorities being required in relation to special Acts for tramways as a condition precedent to such Acts being considered on their merits, and I say that that has an unfair tendency, and is prejudicial to the public interests. If we take the Tyneside Tramways Bill of this last session, which is now an Act, there were altogether nine authorities to get consents from, and five of these were Urban District Councils. Out of these authorities eight consented, four of them being District Councils. The fifth of these, the Urban District Council of Walker, also gave a consent; but the Newcastle Corporation, which is a large landowner in Walker, and which had no Bill before Parliament, persuaded the Walker Urban District Council to withdraw its consent, the Corporation undertaking to go this coming session for an Act of Parliament to make the lines in Walker which would have been made by the Tramway Company, and also to widen a certain road. The effect of that was that the branches of the Tyneside Tramways, which would have best accommodated the Walker manufactories, had to be struck out. There was not a two-thirds consent unless that was struck out, and the consequence was that the manufacturers, who were extremely desirous to have the tramways, are in this position, that they must wait a year longer at all events, because they have to wait for the next session of Parliament to get their tramways. They were almost unanimously in favour of the Tyneside scheme; but in the Walker Urban District Council they have no voice, although they pay nearly half the entire rates. The scheme would have given them the earlier tramways, and now they have to wait, with the possibility that, as the Newcastle Corporation is going for a general raid into the county of Northumberland next year, the ratepayers may throw out the scheme, and then they will have to wait still longer, which is rather a serious position. In all cases the present Standing Orders enable local authorities, even whilst admitting that the proposed tramways are desirable in the public interest, to insist upon burdensome conditions being agreed to before they will give their consent; and they use this power mercilessly, and there is no appeal. This really checks tramway enterprise, and it is thus inimical to the public interests. The third point I mention in my proof is with regard to the powers given to local authorities to interfere in electrical matters, which I say can be exercised to the prejudice of the manufacturing interests of the country. The whole history of the position of the Supply Company in Newcastle with regard to the Corporation of Newcastle amply proves this. These are facts which have absolutely come under my own knowledge, and I have carefully put them into my evidence. I do not try to push it further than that. There may be Corporations which act quite differently, for my knowledge as to that is limited; but these dangers do exist, and occasion very great difficulties. A large generating station is built by a company at Wallsend, which at the present time is supplying in Wallsend 993 kilowatts, and in Newcastle 421 kilowatts. That station, which was opened by Lord Kelvin in May last, has been supplying the manufacturers to the east of Wallsend, which is now a borough on the Tyne. It would have been supplying the manufacturers to the west of Wallsend if it had not been for the interference of the Newcastle Corporation. I do not want to go into technical matters if I can possibly avoid it, because you are more familiar with them and I might make a mistake, but generally I might explain the position in this way. We began in Newcastle in the year 1890 with the alternate-current system. Then it became necessary to change to the direct-current system in conjunction with the alternate three-phase system, and we accordingly built a new large generating station out of Newcastle, at Wallsend. We have also at Wallsend fourteen acres of ground on the river for a yet larger generating station. There is a great demand for electric energy, and it is developing every day among our manufacturers. We were in this position, that we must move out of Newcastle, because the Corporation constantly brought us up before the magistrates for nuisances arising from our condensing plant or our smoke, so that practically at their request we determined to move down to Wallsend. When we did this and began to lay our through mains there came troubles. At first there were great difficulties to get the authority to permit our transmission mains to pass through, and then they entirely stopped our making manholes. We had to appeal to the Board of Trade, and the Corporation consulted experts upon our whole system, and took up the ground that we had no right whatever to have more than one mode of supply, that we must not introduce the direct-current system or the three-phase alternating-current system. They made a great many objections to the Board of Trade, and when we were getting ready for the load of this winter, as early as January last, the Corporation began to stop the work, refusing consent to its proceeding whilst their objections were pending, and from January to July the work was constantly checked by them, and from the middle of June until August 20th they stopped the work entirely. We appealed to the Board of Trade, and ultimately we had a meeting at the Board of Trade and put the case to them in this way: The Department at the present time is supposed to see whether a work is conducted with safety to the public; the Corporation have perfect right to see that in their streets we do what is right and fair, but as to our system we entirely decline to allow them to have any say in the matter, that being our business and in no way theirs. They had cut down our purchase period from forty-two to thirty-one years before they would let us have a Provisional Order at all. They can buy us out now in twenty-one years, and if they wish to dictate how we are to do our business we cannot carry on at all. They would and do keep us back in matters about which they know nothing. The Board of Trade said that was a proper point of view, and they allowed us to go forward, but in the meantime the manufacturers had been kept waiting for current. We could not complete our work. We have even now to grapple with this winter's load, a difficult task, and we have not overtaken the ground we have lost. This is an example of how the powers given to local authorities can be exercised with very great prejudice to the public. I may add that we have made our manholes and are going on to some extent, and now they forbid us to drain the manholes. It is an unreasonable objection. There is probably not one of their officials who would say that it could be upheld. But we may have to come to the Board of Trade to determine the point. Again, we sent in our plans for certain streets through which we wished to put our mains, and we never heard from the Corporation until the last day of the month, the very longest time which they had for objection, and then they said they required further plans. So that in every case, if a Corporation wishes, it can delay electrical work to an extent which I think is often scarcely realised.

STRUCTURAL COSTS.

By A MANUFACTURER.

No. III.*

IN the particular girders under discussion 10s. per ton could have readily been saved by a stricter attention to the preceding condition. But the saving in money is the least part. The time of twenty quoted weeks could have been shortened by more than half. Such girders as these do not take long to make when once the material is in the yard. In an average yard, working at its usual rate, one span per fortnight would be made without effort. But when the main angles, perhaps, arrive first, followed at longer or shorter intervals by the flange plates, bars, tees, &c., and one section does not come for weeks, the manufacturer's hands are tied. To commence work until all the material is ready is very much disliked, because of the increased expense in taking up and putting down, and also of the delay to other work caused by such efforts. Consequently an outside covering period, as a protection to the penalty clause, is usually quoted, and the manufacturer gets much abuse because the foreigner can supply work at a much quicker rate and at a much lower price.

It will also be remembered that the struts and ties of these main girders have to fit into the roots of their main angles. Abstractly considered, this appears a laudable

* No. II. appeared June 13th.

proviso, or, at least, one that can do no harm and *may* conduce to a better girder. No doubt this is the spirit in which the condition was drafted. It was considered that a much neater job would be made this way perhaps than by letting some of the ends touch the angles while others were left proud. I have nothing to say against this. My only point is that if girders are wanted quickly, and are also wanted cheaply, such displays of pedantry or academic ruling must cease. There is a vast difference between wood and iron or steel, and whilst the former lends itself readily and inexpensively to elaborate treatment and working, the latter with its unyielding characteristics defies everything but machines or time; and every extra cut, whether on the square or bevel, adds a definite ascertainable cost to the price of the work. When, in addition to the bevel cut, it is necessary in these struts and ties to shape the ends to fit into an angle root and then down one of the taper sides of the angle, the cost increases tremendously, as such an operation must necessarily be performed by hand if the result is to be that aimed at by the drawings. In order, then, to carry out this injunction, much valuable labour must be put into each end of every tie and strut in the girder, and for what purpose? I have suggested "sightliness" as the motive, but does the finished girder really look any better than a similar one in which these members have been cut proud of the root of the angles, their ends, therefore, being perhaps ¼in. from the horizontal member of the angle? For our own part we cannot see that it does, the latter making a neat finish and one that is incomparably cheaper per end. Can the extra cost, then, be justified by a better girder? Does it in any way enable us to use lighter sections for our members so as to save weight, or does it decrease the necessary number of connecting rivets, giving us a greater net area of section, or save expense in riveting? I doubt whether any engineer would have the hardihood to answer any of these in the affirmative. He would be a bold man who, because he had assured himself of a good butting surface for his struts on to his main angles, reduced their area accordingly or cut out some of his rivets necessary to that area. Frankly, no one would dream of doing this, the laws of stress and strain being too well understood, Where, then, is the benefit we seek? The only other argument that can be advanced might possibly be that a stiffer girder, longitudinally, would result. But if this claim be examined, it is readily seen that there is nothing in it, racking in a girder built this way being an impossibility, even were all its joints articulations; but these joints are securely riveted, each joint having been given its due and proper proportion of rivets commensurate with the stresses to be taken up. No claim of this nature then can possibly hold water. It appears to me, then, that since no good theoretical reason can be advanced in excuse for such extra expenditure, we are thrown upon our first suggestion, that of "sightliness." This, in a commercial structure, being always a secondary consideration, and, in this particular case, a question only of the individual, gives but poor foundation for an order which tends in such a measure to increase costs. It is, indeed, more than likely that such a mundane matter as costs never entered the head of the draughtsman when he provided for this—his thoughts were possibly held exclusively by the notion of getting a "better finished" girder, and everything else went to the wall. And yet his little idea put up the price of these girders to the manufacturer anything from 6d. to 1s. per ton, according to his facilities. These instances might be readily multiplied. I could, for example, call attention to the practice of forming end angles on to main angles in the rail bearers to irregular riveting, where a definite pitch might be adopted, to the use of planed plates where flats would do equally well, &c.; but it is enough to mention them here, leaving the discussion of them until further on, where I can better illustrate my meaning.

So far as the specification is concerned this has already been dealt with in detail as applying to these particular girders, and I would refer the reader to previous papers, where it will readily be seen how vital this can be to the cost of a structure. In passing, however, I would like to just enumerate those clauses contributing most to this and note their relative and approximate influence thereon. First and foremost in my category rank the testing provisions. These are very stringent, and, I think, needlessly so. As has been pointed out, modern firms are not wholly corrupt, and desirous only of evading their every obligation. On the contrary, whilst I will not go so far as to say that the keenest competition is to give the best value for the least price, yet it is well understood that a good average in quality must be made or a reputation in these keen times is soon blasted. That being so, I think much might be gained by a better understanding between the engineer and the maker on this point. Were the latter not so tied down by his conditions that he does not know what fresh demand in this direction may be made upon him, involving work and expense for which he cannot make any extra charge, he would not have to cover himself in estimating and put down those figures that he may eventually be compelled by the action of an inspector to expend, and the price of the girders might be materially reduced. On these particular girders the extra cost due only to these clauses was put down at 7s. 6d. per ton. It would perhaps be hard exactly to define the ways in which this money went. The most of it was claimed by the mills in their extra cost of material; on them lies the onus of proving their product in the first instance, and the extra trouble and cost to them of handling Government steel warrants them in charging an increased price. The remainder is absorbed by the sorting and arranging necessary in the yard to assure a precise inspector that every bar and plate has been tested. Even at the end of all this the manufacturer runs the risk of a sudden whim for further testing, the consequent shortage of piece or pieces, and expense of obtaining and re-testing substitutes. So that when all conditions are weighed, it is seen that such a sum as this, startling though it may appear at first, yet when conditions are better understood actually looks under rather than over the mark, reckoning the risks run.

Second only to the testing clauses comes those governing the finish to be given to the work. It would have been thought by an outsider that bridges built for service such as these—use in tropical climates, far away from civilisation and from critical eyes of the "finnicking" order, the motive dictating their manufacture being that of usefulness solely, possibly never seen by other eyes than those of the drivers as they flash by them, since they left England—would have been required to be built only as strongly as designed and with workmanship in keeping with that end. But, no; everything must be as cleanly finished as hand work can make it, as though the bridge was being made for exhibition as an example of the highest class of finish for prominent structures. All surfaces must most carefully abut, whether requisite for strength or not, all frases be most religiously removed, all ends of stiffeners, kneed tees, gussets, &c., carefully filed and chipped—in fact, after manufacture and the bridge as a bridge is perfect, it must be gone over carefully by experienced men and subjected to a hand finish and cleaning all over, putting on to a bridge of this size and weight a further expense, not necessary in any way to its usefulness, of half-a-crown per ton as a minimum. The writer has frequently had to do with inspectors who will put a small rule or straight-edge along the edge of a gusset with its angles, and insist on these being filed until the rule proves them a true surface—it might have been a valve face by the care they take. All this is very laudable, no doubt, and the inspectors plume themselves on the fact that no ragged work ever escapes their eyes. But it is not structural work. It explains, perhaps as well as anything else, why these orders show a tendency to go abroad. There such smallness of vision is not tolerated, inspectorship of this nature is unknown, and the one object of both engineer and works is to turn out a suitable article for its duty, strong and well made, plainly and inexpensively finished. In short, structural work with its capabilities and limits is much better understood, the result being a cheaper article made in far less time, but just as good for its purpose. The present tendency of these times in this country is, unfortunately for our trade, to exact "glass case" workmanship, and then to turn round and abuse us of the girder yard for our inability to give this at the same price as the foreigner can give his work, minus our finish—which work is readily enough taken by those in authority, either because they do not care to quarrel with strangers, or because, as is so much now the fashion, in their eyes everything at home is radically inferior to what is made abroad. A critical examination of the average foreign-made work plainly shows the intelligent observer, whether skilled or not in technicalities, that hand work is conspicuously absent, that ends and edges everywhere are left in exactly the same state as the machine or rolls or smithy turned them out; and to this fact must be attributed in more than large measure the cut rates at which such work can be delivered.

Finally, we have in the specification, as accounting in some way for the extra cost of this work, those clauses governing painting, packing, tracing of plans, photographs, provision of spare parts, tools, &c. Government is, of course, justified in demanding anything it requires in this direction, but they should also remember that such demands cannot be filled unless they are paid for; and as private work seldom, if ever, requires these things, Government must bear their extra cost. Four coats of Torbay paint must cost more to put on than one coat, and yet, for all practical purposes, the one coat serves just as well until erection as the four do. I do not mean to say there is no object in putting on four coats in this country. Undoubtedly it is specified with the idea that the paint sets better here. So far so good. But after erection it is necessary to repaint. Much of the first coatings has been scraped or scratched away in transit, much is lost in erection, all erection rivets are bare, and the writer is inclined, from personal observation, to the opinion that whilst all the virtue of the first coatings may not be lost, that so little of it remains that the cost of them has been virtually thrown away. It is admittedly necessary to paint after erection, and as oxidisation commences always first at joints and in the awkward places and seldom (with proper precautions) on the broad surfaces, and as it is these same awkward places which have to be painted abroad, expense seems thrown away by painting at home. It is a perfectly legitimate ruling that all surfaces, such as abutting faces of flange plates, &c., should be painted at home before they are riveted together; but since this has to be done in any case, and the four coats under mention are in addition to this, it comes rather outside my argument.

Photographs and tracings of plans are always vexatious. Six duplicates of each of each span under order have to be provided, and hand-made tracings are insisted upon. That all this is not really necessary to the satisfactory erection of standard spans is self-evident, yet still the same clauses get insertion in each successive specification, and whilst not adding much to the extra cost, must count 3d. to 6d. per ton being usually added for this.

The provision of spare parts, tools, &c., and packing go hand in hand, since it is the existence of the former that makes necessary much of the latter. All rivets and bolts for erection have to be supplied, together with 25 per cent. spares, and sets of tools for heating and driving the rivets, screwing down the nuts, &c. With regard to the former, notwithstanding such careful provision and forethought, together with exact lists indicating numbers, sizes, and where for, an examination of bridges now erected and under erection will show wrong-sized rivets put in—three-quarter diameter rivets inserted in seven-eighth holes—oftentimes the lengths also are wrong, and heads are seen either under size or with big frases all around them. So that the provision expressly designed to obviate such occurrences fails utterly—why, does not interest us; the fact remains that it is so, and that consequently the cost of this is also thrown away. Why, then, not save this expense? Let Government buy its rivets and bolts direct and issue them from stores in the usual way; at least, nothing more serious than present conditions would obtain, and much money would be thereby saved. There should be competent foremen on the job who would be held responsible for such happenings, and then the store way is as easy to work as present methods, and far cheaper. With regard to the latter, there must be by now in some of our Colonies hundreds of complete sets of riveting and other tackle, if they were accounted for, and still more has to be sent with each order. To me such conduct of affairs appears sheer wastefulness. Money is money, and if stores are to serve their purpose, let them do proper work, or else abolish the counterfeit entirely. To render necessary these clauses, great neglect and utter incompetency is apparent somewhere, and as anything from 2s. to 4s. per ton could be saved here, only sheer stupidity will further insist on them.

To sum up these 100ft. spans, then, I have pointed out that the following amounts per ton are capable of being saved to the nation:—

	Per ton. £ s. d.
In steel and other material	0 10 0
In testing of ditto	0 7 6
In treatment of detail	0 1 0
In "finish"	0 2 6
In painting	0 7 6
In photographs and tracings	0 0 6
In "spare parts," &c.	0 4 0
Total	£1 13 0

I do not claim that this is the utmost limit of economy. For instance, I might enumerate several smaller and less important points, but which all increase cost* quite up to the limit of a former given figure—roughly, £2 per ton. Thus is the nation's money thrown away as the result of the growth of a system in this country which has destroyed the individuality of the manufacturer.

AMERICAN LOCOMOTIVE CONSTRUCTION.

BY AN AMERICAN ENGINEER.

No. V.†

HAVING now given the general description and specifications under which this Chicago and North-Western engine was built, we may now proceed to describe it more in detail, and to illustrate a number of its detail parts.

The boiler is of the extended wagon-top type, with a single cylindrical course 5ft. 5in. inside diameter. The back head is inclined, an arrangement followed in many recent American engines, to reduce the weight without reducing the length of the grate. The barrel of the boiler is supported at two points by vertical transverse plates resting on the frames. These carry angle irons curved to form seats for the boiler. One of these, near the middle of the barrel, is attached to the boiler by studs; the other—over the slide bars—leaves the boiler free to expand and contract. The fire-box is 9ft. 3in. long on the outside, and is set above the rear driving wheels, the front portion of the grate being inclined. The smoke-box is 5ft. 1½in. long, and is braced to the bumper beam by diagonal bars in the usual way.

The throttle, or regulator, with its position in the dome, is shown in Fig. 8. On the end of the steam pipe is a vertical casting or pipe A, 6½in. diameter inside. This is secured by bolts passing through lugs on the casting, and a brace strap B attached to the inside of the dome by stud bolts. The bottom of the casting also has lugs for the attachment of a U-bolt or stirrup to support the end of the elbow casting C, which forms the steam pipe connection, a brass ring being fitted between the two castings. In the projecting head of the casting A fits a double-seated poppet valve D. The valve admits steam only from above, although on many railways balanced poppet valves are used, admitting steam from above and below. The rod E, from the regulator handle in the cab, is attached by a jaw F to the vertical leg of a crank lever G, pivoted to a lug on the pipe casting A. The horizontal leg of this lever is forked, embracing the vertical pipe casting, and its travel is limited by stops H cast on this pipe. A stop on the vertical leg of the lever limits the travel in the opposite direction. From the vertical leg at the root of the fork projects an arm K, to which is attached the forked end of the valve rod L. The pivot pin of the crank lever rests in a vertically-slotted hole in the lug, so that the lever arm K will raise the valve $\frac{3}{16}$in. before the long lever arm rests on its fulcrum bearing, as shown.

The frames are 34ft. 5½in. long over all, and they are spaced 3ft. 8in. apart between centres. Their form and details are shown in Fig. 9. The width is 4½in. throughout. The front rail A is a separate bar, 6in. to 8in. deep, recessed for the cylinder attachment, and its rear end is butted against the first pedestal on the main frame, being gripped between the top bar or top rail B and a projection on the pedestal. To these it is secured by keys and bolts. The top rail of the frame is 5in. deep over the boxes, 4½in. deep between the boxes, 3in. where it is attached to the front rail, and 3¾in. deep behind the rear axle. The bottom rail or pedestal brace C is 2¾in. to 3½in. deep, while the inclined back brace D is 2½in. to 3in. deep, all being 4½in. wide. The depth of the frame is 25½in. between the pedestals or hornblocks E, while the depth over the pedestals is 2ft. 7in. The feet of the pedestals F have 2¼in. through bolts, with double nuts and keys; spacing sleeves or thimbles on the bolts being fitted between the feet of the pedestals under the axle boxes. The leading leg of each pair of pedestals or hornblocks is vertical, and is fitted with a shoe or gib G. The rear leg is inclined, with a taper of ¾in. in 12in., and is fitted with a wedge H, adjustable by a vertical bolt

* See the *Manufacturers' View*, November 8th and 15th, 1901.
† No. IV. appeared June 13th.

through the bottom of the frame—as was shown in Fig. 1. The wedge and shoe allow of the adjustment of the axle-boxes and bearings, and the wedges are fitted with 1¼in. clearance above the thimbles. It will be seen that the construction makes a stiff frame over the driving wheels, while the single front rail admits of a certain amount of flexibility between the bogie and the driving wheels.

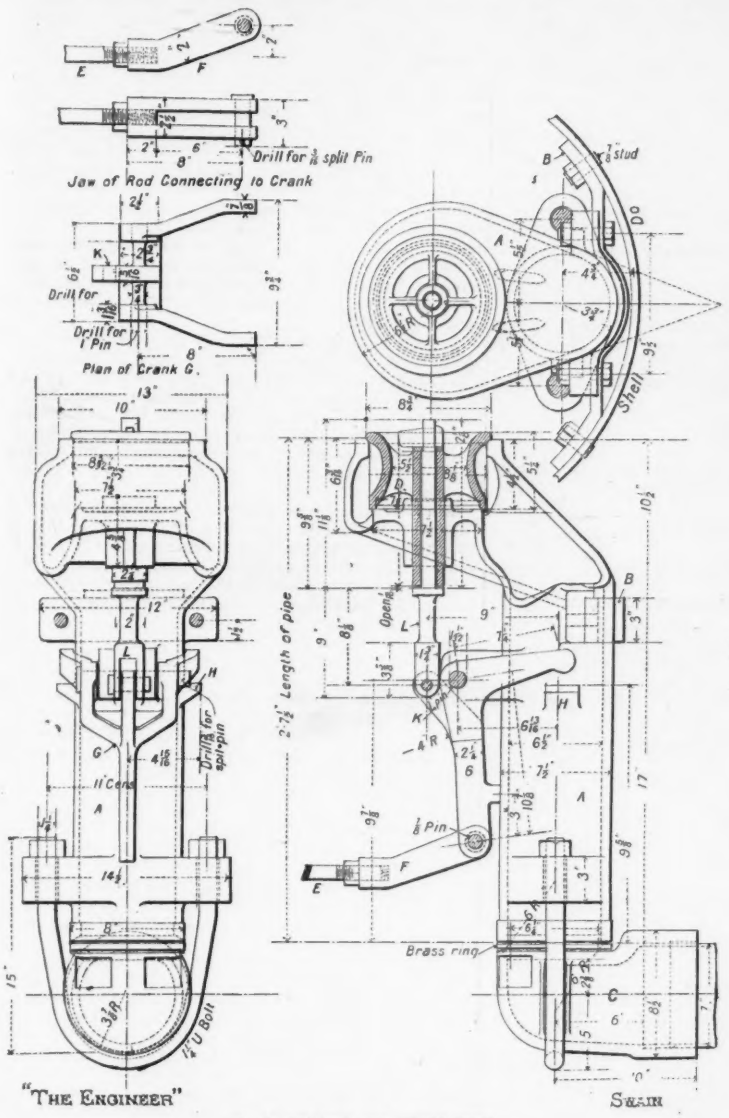


Fig. 8—DETAILS OF REGULATOR

This construction, it should be noted, is for engines having four-wheeled bogies. Those with two-wheeled bogies usually have the top and bottom bars of the main frame extended the whole length, embracing the saddle casting.

All bolts in the frame have a taper of $\frac{1}{16}$in. in 12in. To the end of the front rail is attached the knee J, while to the main body of the frame are attached the steel castings K and L.

The arrangement of the springs has been shown on page 581. The four-wheeled bogie is independent of the driving springs, while the latter are all connected up to form one system. The first two driving axles have elliptic or plate springs above the boxes, each spring having nineteen plates ⅜in. by 5in., and the length being 3ft. 6in. between hangers. The front hanger is attached to the frame, and the two intermediate hangers are connected to an equalising beam. The rear driving axle has a yoke seated upon the axle-box, the front end being attached to an equalising beam carrying the rear

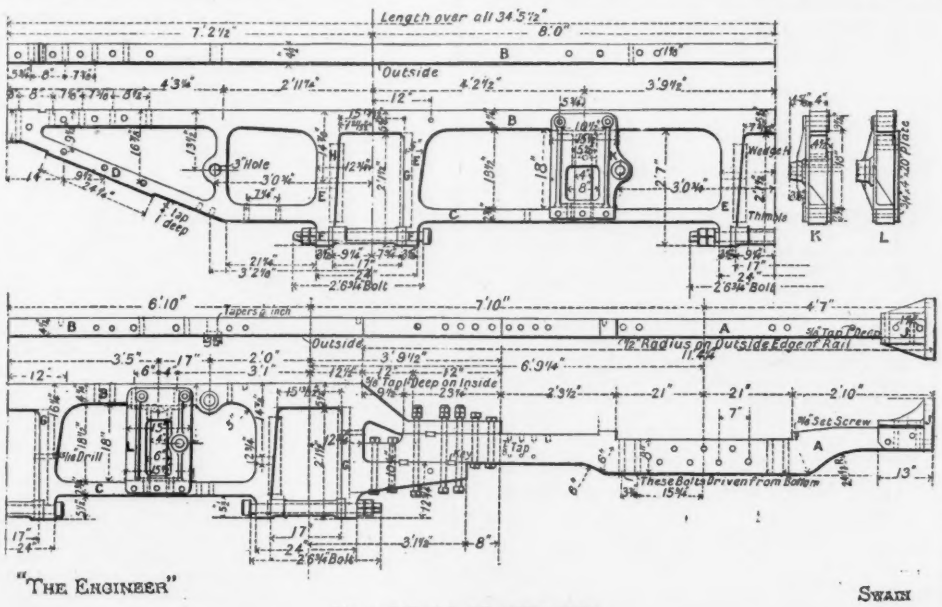


Fig. 9—DETAILS OF REGULATOR

hanger of the second axle. The rear end of the yoke has an anchor rod and plate, with heavy coiled springs seated between this plate and the bottom end of the frame.

The cylinders are 7ft. 2in. apart between centres, and the steam chests are 4ft. 7in. between centres. The cylinder and saddle casting—Fig. 10—forming the support of the smoke-box, is essentially similar to that of the engine previously described, except that a cylindrical steam chest 12in. diameter, for the piston valve, is formed in the casting. This steam chest has a bushing of ¼in. metal, 18¾in. long, with ports cut in the walls, as shown. The cylinder is also bushed, the bushing being ⅜in. thick, reduced to ⅝in. at the ends to form a counter bore. The cylinder casting is 35in. long over all. The form of the piston valve is shown in Fig. 11. It is 24¾in. long, with two piston heads $10\frac{3}{4}$in. diameter, each head being fitted with three spring packing rings, ⅛in. wide and ⅜in. thick. These give a diameter of $11\frac{1}{32}$in. before being compressed to enter the 11in. bushing. The hollow central stem of the valve has an inside diameter of 4in., with walls ⅜in. thick. The 1¼in. valve stem passes through the valve, and is excentrically located, its centre line being ¾in. below that of the valve. The valve stem has a collar fitting the front head of the valve, and is secured by a nut and split cotter behind the rear head.

It will be noticed that the valve gear arrangement is different from that of the first engine described. The excentrics are on the second main driving axle, and the

Fig. 10—CYLINDER AND SADDLE CASTINGS

link—suspended in the usual way from the reversing shaft—is behind the first driving axle, and has a radius of 4ft. 10in. The sliding block, however, is not connected directly to an arm on a rocking shaft above the link, but this shaft is placed over the guides, and is driven by a connecting-rod from the link. This rod is of H section, and is curved to pass over the front driving axle. The rocker arms for this connecting-rod and for the valve rod both project below the rock shaft, while in the other

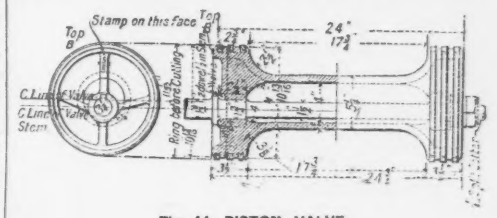


Fig. 11—PISTON VALVE

engine the valve rocker arm projected above the shaft. It is of cast steel, 14½in. long over the arms and 4in. diameter, with a 2in. core hole through it. The arms are 12½in. long between centres of bearings, and a case-hardened wrought iron bushing is pressed into one of the holes. The shaft works in a babbitted bearing in a standard or "rocker box," seated on the frame and against the guide yoke, as shown on page 581.

The piston is a hollow steel casting, without bull ring or follower plate, the packing being let into grooves in the

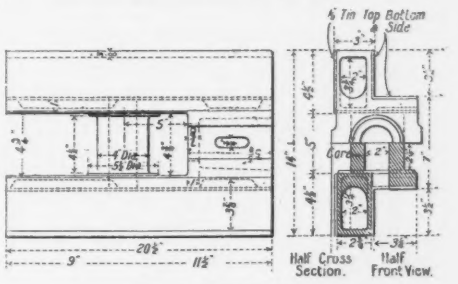


Fig. 12—CROSSHEAD

body of the piston. The diameter is $20\frac{1}{16}$in. over the body, and 21in. over the packing rings. The width is $5\frac{3}{8}$in. for the main portion, but the edges are bevelled off to a width of $4\frac{7}{8}$in. on the face. The two discs of the casting are ¾in. thick, and are reinforced by 1¼in. stay bolts tapped into them at each hollow space, these spaces being separated by radial ribs. The thickness of the face is 2in. The centre hole has a taper of ¾in. in 12in. for the end of the piston-rod, with a recess in front to fit a collar on the rod, and a larger recess in the rear for the nut on the threaded end of the rod.

The packing is of the Dunbar type, already described, two rings being used. Each ring is ¾in. wide, composed

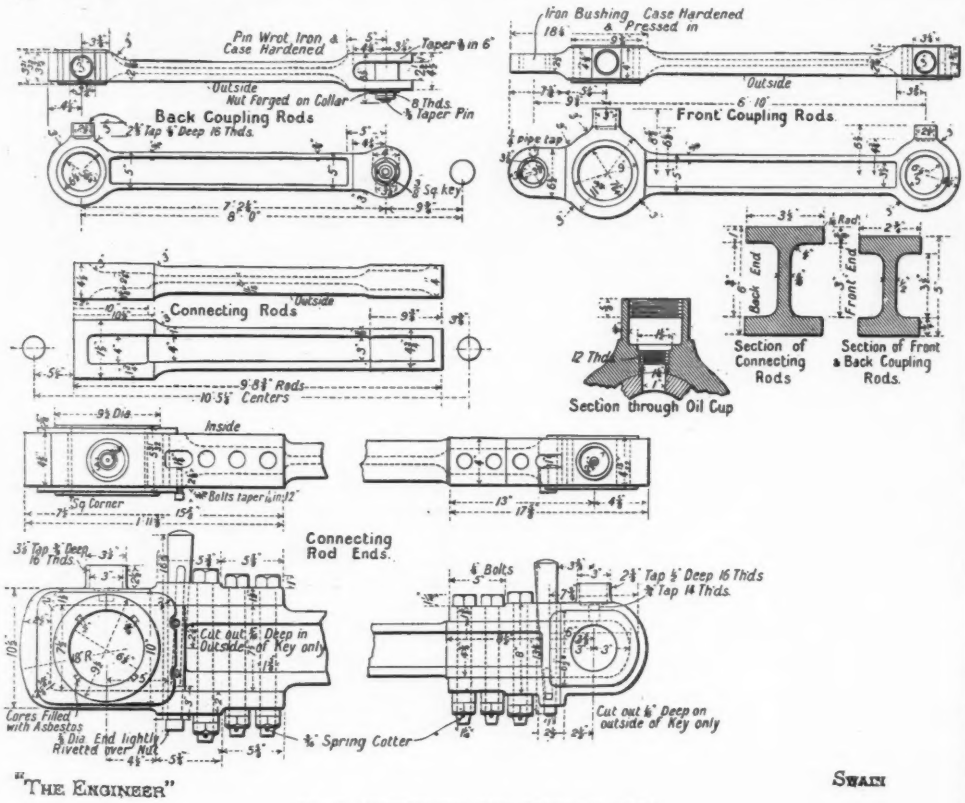
of two parts, are of L section, and are of rectangular section fitting into the first. Under each packing ring are three coils of $\frac{3}{16}$in. coppered spring steel wire, to set up the rings. The L-shaped ring is cut into six equal parts. A piece is cut out of the small ring, and this ring is then also cut into six equal parts. A stop piece is riveted to the L ring to keep the joints broken or alternated.

The piston-rod is 3¾in. diameter in the body, with a head tapering ¼in. in 12in., from 3$\frac{13}{16}$in. at the rear. The back end or piston-fit tapers ⅜in. in 12in. from a largest diameter of 3½in. back of the collar, which fits a recess in the piston.

The crosshead—Fig. 12—is a steel casting, having a socket to receive the head of the piston-rod, which is secured by a flat key driven horizontally through keyways in the crosshead and rod. This key is ⅜in. thick and 9½in. long, tapering from 3⅛in. to 2¼in. in width in a length of 9in. It is of spring steel, with no finish on the sides, which are rounded. When driven up it is secured by a split pin. The wings or slides are 20½in. long, and have bearing surfaces 3¼in. wide on the lower slide bars and 4¼in. on the upper slide bars. The wings are 4¾in. apart, and between them is the 4in. hollow wrist-pin for the connecting-rod end, this pin having a 2in. hole through it. The top, bottom, and side faces of the wings are faced with ⅛in. of tin.

The guides or slide bars are of the four-bar type, the upper bars being 4½in. wide and the lower ones 3½in. wide. The crosshead is of T shape, as shown in Fig. 12, and the sides of its lower part fit between the lower slide bars. The bars are about 3in. thick, spaced 3in. apart vertically by means of sleeves on the end bolts. The front end bolts also carry a cross brace or stirrup, which is depressed to allow for the movement of the connecting-rod. The inner ends of the slide bars are attached to the cylinder head casting, while the outer ends are attached by stud bolts to the flanged end of the steel plate guide-yoke or spectacle plate, shown in Fig. 12. This plate is 1½in. thick, 10in. deep in the horizontal portion, and 14in. wide at the lugs or flanges to which the slide bars are bolted.

The connecting-rods and coupling rods are shown in Fig. 13. They are of steel, of H section, finished all over, and having the corners of all the bodies rounded off to a radius of $\frac{1}{16}$in. The connecting-rods have strap ends, secured to the body by three bolts with washers, and $\frac{3}{16}$in. spring cotters. The main brasses are set up by wedges or keys, having slots or grooves $\frac{1}{16}$in. deep in one side for the set screws which clamp them in position. At the crosshead end the wedges are secured by a set screw and spring cotter. At the crank pin end, or big end, the wedge has two set screws at the sides, while its end is threaded for a nut and lightly riveted over the nut. All the brass bushings are forced in by hydraulic pressure, and the crank pins have asbestos strips let into the face. Oil cups are forged on the coupling rods and on the straps of the connecting-rods. The design and dimensions of these rods are based upon calculations made by the mechanical engineer of the locomotive—or motive power—department.



"THE ENGINEER" SWAIN

Fig. 13—CONNECTING AND COUPLING RODS

The crosshead end or piston-fit tapers ⅜in. in 12in. from a largest diameter of 3½in. back of the collar, which fits a recess in the piston.

The crosshead—Fig. 12—is a steel casting, having a socket to receive the head of the piston-rod, which is secured by a flat key driven horizontally through keyways in the crosshead and rod. This key is ⅜in. thick and 9½in. long, tapering from 3⅛in. to 2¼in. in width in a length of 9in. It is of spring steel, with no finish on the sides, which are rounded. When driven up it is secured by a split pin. The wings or slides are 20½in. long, and have bearing surfaces 3¼in. wide on the lower slide bars and 4¼in. on the upper slide bars. The wings are 4¾in. apart, and between them is the 4in. hollow wrist-pin for the connecting-rod end, this pin having a 2in. hole through it. The top, bottom, and side faces of the wings are faced with ⅛in. of tin.

The guides or slide bars are of the four-bar type, the upper bars being 4½in. wide and the lower ones 3½in. wide. The crosshead is of T shape, as shown in Fig. 12, and the sides of its lower part fit between the lower slide bars. The bars are about 3in. thick, spaced 3in. apart vertically by means of sleeves on the end bolts. The front end bolts also carry a cross brace or stirrup, which is depressed to allow for the movement of the connecting-rod. The inner ends of the slide bars are attached to the cylinder head casting, while the outer ends are attached by stud bolts to the flanged end of the steel plate guide-yoke or spectacle plate, shown in Fig. 12. This plate is 1½in. thick, 10in. deep in the horizontal portion, and 14in. wide at the lugs or flanges to which the slide bars are bolted.

The connecting-rods and coupling rods are shown in Fig. 13. They are of steel, of H section, finished all over, and having the corners of all the bodies rounded off to a radius of $\frac{1}{16}$in. The connecting-rods have strap ends, secured to the body by three bolts with washers, and $\frac{3}{16}$in. spring cotters. The main brasses are set up by wedges or keys, having slots or grooves $\frac{1}{16}$in. deep in one side for the set screws which clamp them in position. At the crosshead end the wedges are secured by a set screw and spring cotter. At the crank pin end, or big end, the wedge has two set screws at the sides, while its end is threaded for a nut and lightly riveted over the nut. All the brass bushings are forced in by hydraulic pressure, and the crank pins have asbestos strips let into the face. Oil cups are forged on the coupling rods and on the straps of the connecting-rods. The design and dimensions of these rods are based upon calculations made by the mechanical engineer of the locomotive—or motive power—department.

THE aggregate capital invested in the world's railways is £6,532,339,200, of which no less than £3,634,022,800 has been invested in 162,225 miles of European railroads, which have an average capital of £23,918 per mile; while the average of 263,356 miles in the other parts of the world is £11,006 per mile. As there are 65,000 miles whose capital is not reported, we are safe in assuming that the world has £7,200,000,000 invested in its railways.

CAPPED ARMOUR-PIERCING PROJECTILES

Now that public attention has been drawn to the efficiency of caps on armour-piercing projectiles under certain conditions, a few remarks on the subject may not be out of place.

It may be well to discuss the general subject of penetration of plates before proceeding to the special one of capped projectiles. In former years, when wrought iron plates were attacked by steel projectiles, the latter usually remained whole, whether complete perforation was effected or not, though projectiles of inferior material or design often set up considerably in doing so. But on the introduction of compound plates, where the hard steel face was welded on to a wrought iron back, the superior hardness of the face sometimes caused the projectile to break up on striking; and with the advance to Harveyed or other hardened steel faces to the plates, up to the modern Krupp cemented plates, the tendency to break up the projectile has increased faster than the projectile makers have been able to meet it by improvements in their materials.

The problem with which the artillerist is faced is to a great extent indeterminate, and has to be met mainly in an empirical and theoretical manner, as the exact cycle of events in the penetration of a modern plate by a projectile moving at a very high velocity—from 2000 to 3000 foot-seconds—is practically unknown. Apart from complete shattering of the plate, which only occurs when it is too small superficially for the projectile by which it is attacked, penetration may be effected by punching or boring, the former being the most common, though connected by insensible gradations with the latter. In the extreme cases punching is effected not by the driving out of a cylindrical plug, as in the engineering acceptance of the meaning of the term, but by the removal of a more or less conical or mushroom-shaped portion of the plate, usually designated a disc, which is approximately of the diameter of the projectile on the face, and two or three or even more times as great on the back. The face of the disc presents a central depression, usually cup-shaped and almost hemispherical, but sometimes sub-conical, and in extreme cases the central cylindrical portion is partially punched through the disc. It would appear as though the latter action occurred early in the cycle of events constituting perforation, as the complete removal of a cylindrical plug appears never to be accompanied by the removal of the disc, the yielding of the plug removing the strains which tend to the separation of the disc, thus localising the action. This punching action, in the limited application of the word, is not always clearly defined, the plug not always being recoverable after the perforation of the projectile. When it is found it usually has a considerable quantity of the head of the projectile in a disintegrated form welded on to its face, often to a thickness of several inches, but in other cases the plug is shattered and only recoverable in fragments, and it becomes difficult to determine whether the perforative action of the projectile has been by punching or by that action which, for the want of a better term, we have called boring.

When the projectile first strikes the plate the whole energy is delivered by the extreme point, and in most cases the latter is completely crushed out of recognition, the head of the projectile assuming a roughly hemispherical form, though in cases of oblique attack the extreme point for a length of ½in. to 1in. is sometimes recovered broken off and undamaged, having probably parted from the rest of the projectile immediately on striking.

In order to preserve the extreme point from damage so as to assist it in delivering the full energy of the projectile at the point of impact, the idea occurred of attaching to it a cap of soft, but tough, steel. Such caps are either cylindrical in form, or may follow the ogive of the point, and are attached by various methods, mechanical or magnetic, most of which form the subject of patents.

Just as the precise cycle of events which takes place in the perforation of a plate is not clearly known—for example, to what extent the plate backing springs on being struck, or at what stage the disc or plug yields, or the projectile breaks up—so the exact nature of the assistance which the cap affords is the subject of much discussion. Its primary action is doubtless that it holds the point together sufficiently long to enable a much greater proportion of the energy of the projectile to be delivered on the plate than is the case with an uncapped projectile, but it no doubt also acts as a lubricant, not only for the passage of the projectile in the direction of its axis, but also for its rotary motion, the stresses due to which are doubtless very considerable when the head becomes welded into the plate, while the rotation of the body tends to continue. So long as the projectile holds together this rotary stress can have no effect on the perforation, but it is one of the stresses which breaks it up, an action which it is desirable to prevent or postpone as long as possible.

The use of a cap also has been supposed to affect the time element, by delaying the breaking up of the head of the projectile so that the plate yields before the projectile, but we venture to think that this also has an adverse effect on the body, which derives no benefit from the cap, and which, if given time, may set up or break before the maximum of energy has been delivered against the plate. The invention is by no means very recent, wrought iron caps having been tried on Palliser projectiles twenty-five years ago with a distinct promise of success, but we now appear to have fallen behind the various foreign countries in our introduction of caps, in spite of the various projectile makers' efforts to urge their use. Messrs. Hadfield, of Sheffield, have had some very successful trials, both in this country and abroad, of their capped projectiles.

The trials which have been carried out in this country by the War Department and the Admiralty have not, as a rule, been made public, but it is understood that, generally speaking, it has not been proved that any great perforative advantage has been derived from their use when the plates are attacked normally, a condition which would comparatively seldom present itself in a naval engagement, or the attack of ships from the shore, while in oblique attack a positive disadvantage has been shown. The latter objection appears to have been one that might have been anticipated. As the attack becomes more oblique, the more important it is that the point of the projectile should bite on the plate, whereas the interposition of a comparatively soft cap must cause a tendency to slip, besides forming more of a cushion to the blow than when the plate is directly in front of the point, as in normal attack.

The efficiency of the cap undoubtedly increases greatly with the velocity. Results published in America show that the efficiency in normal attack at 2500ft. striking velocity is nearly treble that at 1900, the increased perforation at the higher velocity being about 30 per cent. as compared with an uncapped projectile, whereas at the lower velocity it is only about 12 per cent. The recently published results at Eskmeals point to the same conclusion, and we venture to think that one reason our country has been slow to adopt capped projectiles has been that our trials have been carried out with velocities too low to show their advantages, but no doubt the War-office has also been influenced by that commendable caution which they always exercise in adopting any new invention before it has been thoroughly tested. Moreover, our standard armour-piercing projectile is a shell, the design of which is too weak to derive full benefit from the use of the cap, the higher work it is thereby called upon to perform tending to break it up more instead of increasing the perforation.

SOME MODERN TENDENCIES OF LOCOMOTIVE ENGINEERING.

By CHARLES ROUS-MARTEN.

No. IV.*

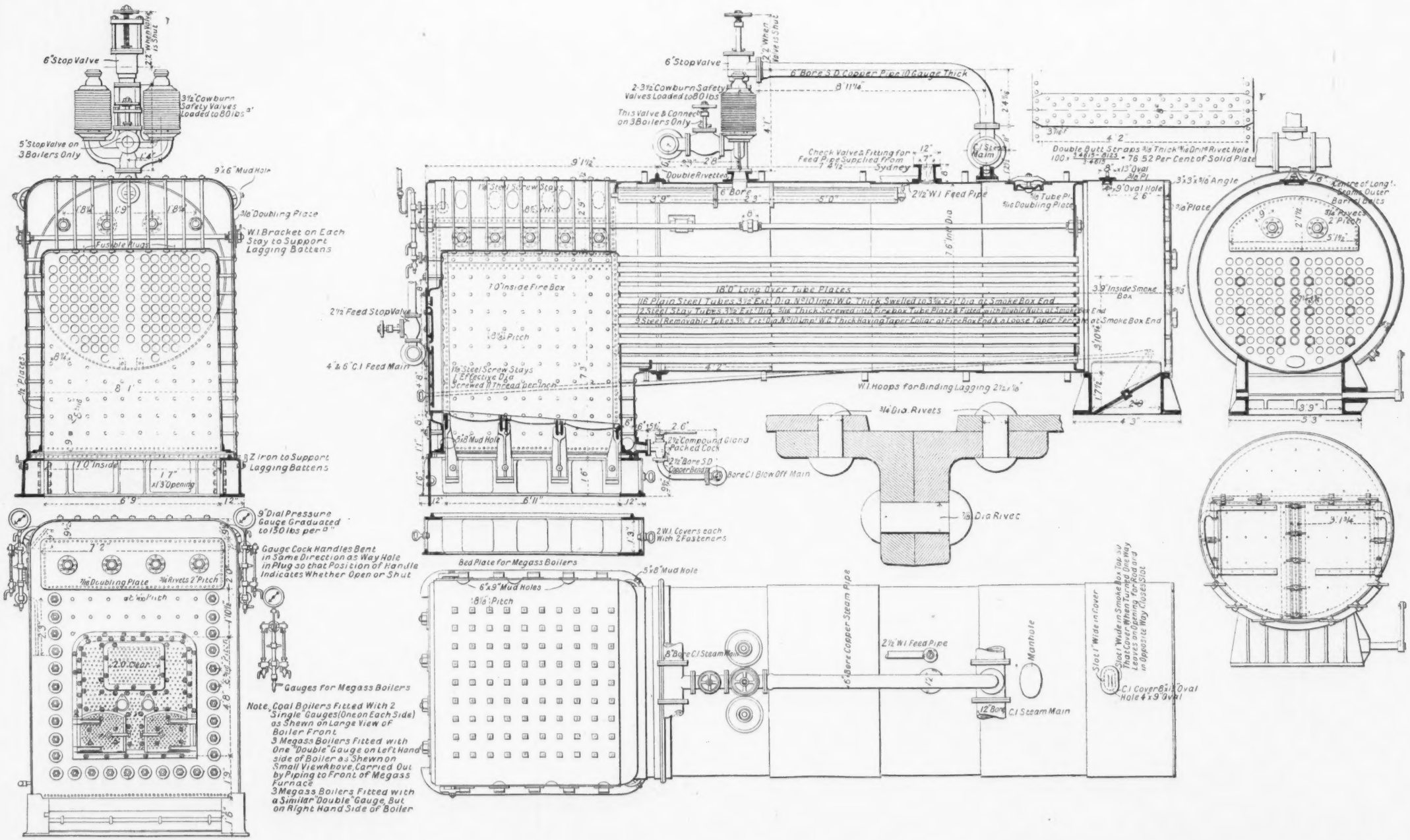
SIMILAR, although in a smaller degree, has been the experience of the London and South-Western. Mr. Beattie, in the last express locomotives that he designed, his "350" class, had enlarged his cylinders from 17in. by 22in. to 18½in. by 26in. But their boilers could not keep such big cylinders going with only about 1000 square feet of heating surface, and so when Mr. W. Adams took charge he promptly lined up the cylinders to 17in., and in the numerous express engines he designed and built for the London and South-Western, all excepting his latest type had cylinders 18in. by 24in., *e.g.*, the "140," "450," and "470" classes, associated with somewhat larger boilers. But when more power was demanded, Mr. Adams designed a type with 19in. cylinders and 26in. piston stroke, of which no fewer than sixty were constructed, thirty—Nos. 557—576 and 657—666—having 6ft. 6in. coupled wheels, while in the other thirty—Nos. 577—596 and 677—686—the wheels were 7ft. in diameter. The boilers had a heating surface of 1367 square feet and a steam pressure of 175 lb. per square inch. On Mr. D. Drummond's accession to the locomotive superintendency at Nine Elms, he adopted the smaller cylinder diameter of 18½in.—retaining the 26in. piston stroke, 6ft. 6in. coupled wheels, and 175 lb. steam pressure—but supplied a far more powerful boiler with 1500 square feet of total heating surface. And further, he resorted to means of enhancing the effectiveness of the boiler power he supplied, employing one of those special devices to which I referred in previous articles. Just as Mr. Dean

* No. III. appeared June 20th.

LOCOMOTIVE TYPE BOILER FOR A SUGAR FACTORY

GEORGE FLETCHER AND CO., DERBY, ENGINEERS

For description see page 628)


6" Stop Valve
2·2" When Valves Shut
3½" Cowburn Safety Valves Loaded to 80 lbs
5" Stop Valve on 3 Boilers Only
9"x6" Mud Hole
⅜" Doubling Plate
W.I. Bracket on Each Stay to Support Lagging Battens
Fusible Plug
4½" Plates
8'1"
10' Inside
17" x13" Opening
Z Iron to Support Lagging Battens
6'9"
12"
9" Dial Pressure Gauge Graduated to 150 lbs per 9"
Gauge Cock Handles Bent in Same Direction as Way Hole in Plug so that Position of Handle Indicates Whether Open or Shut
7'2"
⅜" Doubling Plate
⅝" Rivets 2" Pitch
8⅛" Pitch
2'0" Clear
Gauges for Megass Boilers
Note. Coal Boilers Fitted With 2 "Single" Gauges (One on Each Side) as Shewn on Large View of Boiler Front
3 Megass Boilers Fitted with One "Double" Gauge on Left Hand side of Boiler as Shewn on Small View Above. Carried Out by Piping to Front of Megass Furnace
3 Megass Boilers Fitted with a Similar "Double" Gauge, But on Right Hand Side of Boiler
6" Stop Valve
2·2" When Valves Shut
6" Bore S.D. Copper Pipe 10 Gauge Thick
8'11¼"
2-3½" Cowburn Safety Valves Loaded to 80 lbs
This Valve & Connection on 3 Boilers Only
Check Valve & Fitting for Feed Pipe Supplied From Sydney
7'4½"
C.I. Steam Main
Double Rivetted
9'1½"
1⅛" Steel Screw Stays
6" Bore
2½" W.I. Feed Pipe
⅜" Tube Plate
⅝" Doubling Plate
10" Inside Fire Box
8⅛" Pitch
2½" Feed Stop Valve
4" & 6" C.I. Feed Main
1⅛" Steel Screw Stays Effective Dia Screwed 11 Thread per Inch
18'0" Long Over Tube Plates
118 Plain Steel Tubes 3½" Ext. Dia. No 10 Imp. W.G. Thick Swelled to 3⅝" Ext. Dia at Smoke Box End
2 Steel Stay Tubes 3½" Ext. Dia. ⅜" Thick Screwed into Fire box Tube Plates Fitted with Double Nuts at Smoke Box End
9 Steel Removable Tubes 3½" Ext. Dia No 10 Imp. W.G. Thick Having Taper Collar at Fire Box End & a Loose Taper Ferrule at Smoke Box End
4'2"
W.I. Hoops for Binding Lagging 2½"x⅛"
5⅛" Mud Hole
2½" Compound Gland Packed Cock
2½" Bore S.D. Copper Bend
Bore C.I. Blow Off Main
2 W.I. Covers each With 2 Fasteners
Bed Plate for Megass Boilers
6"x9" Mud Holes
8⅛" Pitch
5"x8" Mud Hole
8" Bore C.I. Steam Main
6" Bore Copper Steam Pipe
2½" W.I. Feed Pipe
Manhole
12" Bore C.I. Steam Main
Slot 1" Wide in Cover
Slot 1" Wide in Smoke Box Top so That Cover When Turned One Way Leaves Slot Open and in Opposite Way Closes Slot
C.I. Cover 8½" Oval Hole 4"x9" Oval
⅝" Dia. Rivets
⅝" Dia Rivet
Double Butt Straps ⅜" Thick ⅞" Dia Rivet Hole
100 x 3.4815 / 3.8125 = 76·52 Per Cent of Solid Plate
4'2"
8"x13" Oval
⅜" Pl.
9"x9" Oval Hole
2'6"
3½"x3½"x⅜" Angle
⅜" Plate
6" Centre of Long. Seams Outer Barrel Butts
⅝" Rivets 2" Pitch
5'1½"
3'9" Inside Smoke Box
3'10½"
4'3"
5'3"
3'1¾"

"THE ENGINEER"

SWAIN.

had sought to gain this advantage by improving the efficiency of his fire-box, so did Mr. Drummond—only whereas Mr. Dean preferred to employ the Belpaire method, Mr. Drummond introduced a new plan, the water-tube box. In each of these cases the steam generative capacity of the locomotive is expanded considerably beyond the figure which would be indicated by the same area of heating surface disposed in the ordinary way. So far as I have been able to judge by actual personal experience, Mr. Drummond's water-tube system appears to have proved completely successful in practice, and the drawbacks which were anticipated by many capable critics—such as the blockage of the tubes by incrustation—do not seem to have made themselves felt even in the smallest degree, the movement of the water and steam either preventing the formation of scale or else sweeping it clean away in its incipient stage of formation. The easy accessibility of he tube-ends for inspection or cleaning under the newer method of arrangement devised by Mr. Drummond—access being had through doors at each side of the external shell of the fire-box—has apparently removed all objections which otherwise might apply to the use of these water tubes, and their usefulness as potent factors in the work of steam generation is self-evident.

How far their advantages may be discounted by increased construction-cost I am unable to say—indeed, it is perhaps still too soon to pronounce definite judgment on this head—but my personal opinion is distinctly favourable to the plan, judging from the work done under my own observation by engines fitted with the water tube fire-boxes. The system seems to possess distinct superiority over the *bouilleur* used in some French locomotives, which was found to be so expensive in upkeep that when worn out it has in many cases not been replaced. Nor does the Tenbrinck water-arch appear to be coming into large adoption. On the other hand, I fully expect to see the Drummond system come more and more into vogue as its advantages are appreciated. It would be very interesting if a thorough comparison could be made between the results given respectively by the Drummond and Belpaire methods. The latter has made large progress of late in British acceptance. It is now in extensive use on the Great Western, Midland, Great Eastern, and Lancashire-Yorkshire Railways, where it seems to show highly satisfactory results. It is not a little curious that just at the time when the Belpaire system seems to be making its way so steadily in Britain it should be going out of use in the country of its origin, Belgium. M. Bertrand, the able chief mechanical engineer of the Belgian State Railways, informed me some time ago that he was discontinuing the construction of locomotives with fire-boxes on that plan. Indeed, Mr. J. F. M'Intosh's Caledonian designs, alike for passenger and for goods engines, seem paramount on the Etat-Belge system, and all the newest engines I have seen belonging to that railway for passenger and goods service respectively have been either of the "Breadalbane" or the "812" Caledonian class, each being Mr. M'Intosh's design. These, of course, do not possess Belpaire fire-boxes.

In the cases of the London, Brighton, and South Coast Railway and the South-Eastern and Chatham lines an increase of boiler power has been obtained through enlargement of the cubical capacity of the barrel and extension of the heating surface, the ordinary types of boiler and fire-box being employed in the new engines alike of Mr. R. J. Billinton's "Sirdar" class and of Mr. H. S. Wainwright's "730" type. Each is a fine-looking machine which should be equal to far more than the present demands upon its capacity in respect of speed with heavy expresses, but so far I have not had much experience as to the actual performance of either. On the Great Eastern, too, Mr. J. Holden uses a boiler of the normal order for his newest express engines of the "Claud Hamilton" class, but of large size, and having over 1600 square feet of heating surface. His fire-box is unique in being fitted with his very admirable and efficient patent apparatus for burning liquid fuel in association with coal. Here, again, it will be observed the special feature is to be found in the fire-box.

The case of the Great Northern is somewhat peculiar. When Mr. H. A. Ivatt took charge six or seven years ago he found the fastest-timed expresses in England, and some of the heaviest too, being run on a road, much of which is by no means easy, with locomotives, not one of which possessed more than 1045 square feet of heating surface. It was one of the curious and seemingly paradoxical characteristics of the late Mr. Patrick Stirling's methods that the bigger the engines he built and the larger their cylinders the less heating surface he gave them. I am referring now to his standard express types. When in 1869 he designed his famous "No. 1" of the 8ft. single-wheelers, he provided only 1165 square feet of heating surface for 18in. cylinders with 28in. piston stroke. When these engines were given new boilers, their cylinders had been bored out to 18½in. diameter, yet they received only 1045 square feet of heating surface. And, finally, when Mr. Stirling brought out, just before his lamented decease, his last and largest six, Nos. 1003—1008 (five of which had 19½in. cylinders and one 19in., all having 28in. piston stroke) he gave them only 1031 square feet of heating surface. And yet the smaller their heating surface the better work the engines seemed to do. The explanation is doubtless to be found in the superiority of the method employed in the disposition of the tubes and fire-box, which caused a smaller heating surface to do the work usually performed by a much larger area less favourably arranged. I am not aware that a satisfactory explanation has ever been forthcoming of the extraordinary feats sometimes achieved by both the earlier and the later types of 8ft. single-wheelers designed by Mr. Stirling, or by his 7ft. 7in. single-wheelers, which had boilers of identical dimensions, with 1045 square feet of heating surface, and cylinders 18in. by 26in. Certainly those achievements did at times appear to infringe all theoretical ideas as to what was feasible with such limited amounts of tractive force' adhesion, and boiler capacity.

It was another of Mr. Stirling's peculiarities of method that he should have given to the 6ft. 6in. coupled engines, of which he built such large numbers, an even smaller amount of heating surface—only 918 square feet, with cylinders 17½in. by 26in. In this case, however, unlike that of the single-wheelers, the deficient boiler power did make itself disagreeably manifest. It is true that these 6ft. 6in. coupled engines behaved well enough when used in running light fast trains or heavy slow trains. But when set to haul heavy fast-timed trains, they—according to my own experience in many scores of instances—invariably lost time, notwithstanding that they possessed 102 lb. of tractive force for every pound of steam pressure on the pistons, as against only 94 lb. in the case of the 8ft. single-wheelers—excluding the last six—and 97 lb. in the case of the 7ft. 7in. class. The reason manifestly was shortness of steam, for although they had to fill their cylinders so much oftener at a given rate of travelling speed than had the engines with 8ft. or 7ft. 7in. wheels, their cylinders, being only 17½in. by 26in., were of far smaller cubical capacity than the 18in. by 28in. cylinders of the 8ft. class, or than the 18½in. by 26in. of the other single-wheelers. Their designer once asserted to me that his 6ft. 6in. coupled class could do any class of work that was called for on the Great Northern, from pulling a heavy coal train to running a fast express. This was quite true at that time, for the really fast Great Northern expresses—as we now regard speed—were mostly light, while the relatively heavy expresses of that day were, as a rule, by no means fast-timed. "But all the same," Mr. Stirling proceeded, "I don't like to see coupled engines on express trains." And so, when in his last days Mr. Stirling, who all his life had strenuously objected to "piloting," and had even prohibited it on the Great Northern, was compelled to sanction it, as the standard train loads had grown from 150 to 250 tons, with a marked increase in booked speed, and also had to design a new class better able to grapple unaided with the heavier loads that had to be hauled at higher speeds than those even of the Great Northern's previous days, he remained faithful to the 8ft. single-wheel type, only he gave it an extra 1½in. in cylinder diameter and additional adhesion weight, but 14 square feet less of heating surface.

Then Mr. Ivatt arrived on the scene. He steadily surveyed his ground before he began to advance. He frankly declared his cordial admiration of his predecessor's engines, remarking to me—as did Mr. Aspinall on another occasion—with what curious exactness Mr. Stirling had designed his engines to suit the precise work they were required to do. But the work had outgrown the engines, and so a fresh departure had to be taken. I have described in the columns of THE ENGINEER how Mr. Ivatt first rebuilt some of the old single-wheelers so as to constitute them virtually new locomotives with greatly augmented power, and how at last, when a supply of fresh engines became absolutely necessary, he openly proclaimed his intention of adhering as closely as possible to the lines laid down by his predecessor. The first outcome was the well-known "No. 400," which Mr. Ivatt distinctly declared to be "simply Mr. Stirling's coupled type with larger boiler and a leading bogie"—indeed ten of the class were built without bogies to use up some Stirling frames already in hand. No fewer than fifty of these engines of the "400" type were built, in addition to the pioneer locomotive, viz., Nos. 1061—1080, 1301—1320, and 1341—1369. Practically, so far as power is concerned, they may be said to be the Stirling coupled class with 200 square feet of additional heating surface, their total amount being 1123 instead of 918 square feet. But this increment of heating surface made the most remarkable difference in their efficiency. They have proved, in fact, most useful and handy engines, capable of doing good work all round. But then Mr. Ivatt became convinced that by simply augmenting further the boiler capacity he could greatly increase the power of those engines. Accordingly, he proceeded to construct a fresh batch with cylinders and coupled wheels of the same size as those of the former set, but with much larger boilers, 4ft. 9in. in diameter instead of 4ft. 3in., and higher pitched, the axis standing 7ft. 11in. above the rail level instead of 7ft. 5½in., with 1250 square feet of heating surface. These are numbered from 1321 to 1340 inclusive, and then from 1361 onward. Fifty or sixty of these have been built, with the result that, although their nominal tractive force is no greater than before, they are able to exercise practically far larger power, because they possess plenty of steam. It was about the same time that Mr. Ivatt designed and built his "990" or "Atlantic" class, of which eleven are now running. These have larger boilers, or, at least, they are longer in the barrel, and have 1442 square feet of heating surface, with outside cylinders 18¾ by 24 and 6ft. 6in. coupled wheels.

Both classes have always given me excellent work, and, approximately, one as good as the other. I am dealing with that point now in general terms, and without attempting any exact comparison, but as a rough estimate after many trials I should say that there is little difference between the two types on the score of efficiency.

The curious result remains that with cylinders only 17½in. diameter, 1250 square feet of heating surface, and 6ft. 6in. coupled wheels, Mr. Ivatt appears to obtain work quite equal to that done by many engines possessing alike larger cylinders, larger heating surface, larger tractive force, and higher steam pressure. And it may be added that in his new class of 7ft. 6in. single-wheelers—Nos. 92, 100, 261—270—he has produced a type of engine able to perform satisfactory work usually deemed to be in excess of a single-wheeler's capacity. This suggests once more the reflection that the applicableness of traditional ideas and theories and formulæ to modern locomotive practice must needs be largely conditioned by the circumstances of each individual case and by the results of actual experience.

I must postpone to a future article some further points in relation to this phase of my subject.

PROGRESS OF WARSHIPS AND MACHINERY BUILDING IN ENGLAND.

WE are again enabled, through the courtesy of the private firms engaged in the building of warships and their machinery in England, to present our readers with our usual *résumé* of the progress made in naval constructions during the past six months of the present year. Of similar work effected in the royal dockyards of the country during the same period we are able, as before, from sources other than official, to note briefly what has been done in this connection.

Giving, as is our custom, priority of place in our record to the work completed and in progress in these establishments, we may say that since the beginning of the current year, only one battleship, the Queen, built at Devonport, has been launched, and another, the King Edward VII., laid down on the same building slip, the two events taking place on the same day, the 8th of last March. There was also laid down at Chatham dockyard on the 25th of the same month an armoured cruiser of the County class, to be named the Devonshire. She is one of six sister ships ordered to be built, the remaining five to be given out to contract. They are each to be 450ft. long, and 67ft. beam; to have a displacement of 10,200 tons, and to be fitted with engines of 22,000 indicated horse-power. The typical ship's engines to be supplied with steam by water tube boilers; all the vessels to have a speed of 23 knots.

The vessels reported as still building are the armoured cruisers Suffolk and Cornwall, at Portsmouth and Pembroke; and the second-class cruisers Encounter and Challenger, at Devonport and Chatham respectively; particulars of all of which have been given in previous notices. Two twin-screw sloops, the Cadmus and Clio, vessels of 1070 tons displacement, are also under construction at Sheerness, to be fitted with engines of 1400 indicated horse-power, to be made in the dockyard.

The vessels classed as "completing" in the dockyards are the Queen and Montagu battleships, and the armoured cruiser Bedford at Devonport, the armoured cruiser Essex at Pembroke, and the Fantome, Merlin, and Odin sloops at Sheerness, The battleships Albemarle, Duncan, Prince of Wales, Russell, and Venerable, have all been removed into the D division of the Dockyard Reserve at Chatham, not ready for commission, but to be "finally completed," which often occupies a considerable time in effecting.

Of the Admiralty orders lately given out to contract, one first-class battleship, the Dominion, one first-class cruiser, the Hampshire, and eight torpedo boat destroyers are to be built in England. The order for the machinery of the battleship King Edward VII., building at Devonport, has been given to Harland and Wolff, of Belfast. The battleships are to have a displacement of 16,350 tons, with propelling engines of 18,000 indicated horse-power, and a speed of 18½ knots at natural draught to the boilers, and the cruisers 10,200 tons displacement, with engines of 22,000 indicated horse-power, and a speed of 23 knots. These vessels belong to a programme authorised by Parliament more than a year ago.

Turning now to the private shipyards and works in England wherein warships and their machinery are constructed, the past six months give the following results as the progress made:—

Commencing with the East Coast establishments and coming south, we note that at the Elswick Shipyard, Sir W. G. Armstrong, Whitworth and Company, have launched the armoured cruiser Lancaster, the completion of which is now progressing—most of the propelling machinery being in place on board. The construction of the first-class cruiser Hampshire and of the destroyer Amethyst has been placed with the firm by the British Government, and it has orders on hand for a large battleship for the Chilian, and a cruiser for the Turkish, navies. Two coal haulabouts, each having a capacity of 1000 tons of coal, and intended to be fitted with Temperley's apparatus for coaling warships at sea, were laid down early in the year, and are now practically ready for launching.

Hawthorn, Leslie, and Company, of St. Peters and Hebburn-on-Tyne, have the erection on board of the propelling machinery of the cruiser Kent at Portsmouth well advanced, and the trials of the vessel will take place in October. The whole of the more important parts of the machinery of the cruiser Lancaster—built at Elswick—are in place on board, and it is expected that her trials will be completed before the end of the financial year. The engines of the cruiser Cornwall—building at Pembroke—are being erected in the shops at St. Peters, and will be forwarded to the dockyard in August; the boilers of this vessel, which are of the Babcock and Wilcox type, are well advanced, and it is expected the vessel will be launched about October. The order for the machinery of the cruiser, Hampshire—building at Elswick—having only lately been received, work upon it has not yet really commenced.

It is interesting to note that Hawthorn, Leslie, have in hand four sets of machinery for vessels of the County class, each of 22,000 indicated horse-power. As the engines are practically similar in all respects, a favourable opportunity is given of comparing the results attained with the various types of boilers at present on trial for warships. The Kent and Lancaster are therefore to be fitted with the Belleville type, the Cornwall with the Babcock and Wilcox, and the Hampshire with a combination of the old cylindrical and large tube Yarrow boilers. Hawthorn, Leslie, have also in the early stages of progress, the machinery and boilers—the latter of the Yarrow type—of the Derwent, one of the new type of torpedo boat destroyers recently ordered; together with the boilers—to the order of the Parsons Marine Steam Turbine Company—of the modified Yarrow type for the destroyers Eden and Amethyst, the former being built at their Hebburn shipyard, and the latter at Elswick. Up to the present time, however, these boilers are barely commenced.

Palmers' Shipbuilding Company at Jarrow have com-

pleted and delivered over to the naval authorities the battleship Russell built at the works, which has since passed through her steam trials. The Gossamer, torpedo gunboat, has been fitted with new engines and boilers, and similar work is being done to her sister ship the Niger. The firm is also busy with alterations to the cruisers Medea and Medusa, new boilers being fitted to them at the instance of the Boiler Committee, the former vessel to have those of the Yarrow, and the latter the Dürr type of water-tube boiler. Palmers Company' has also received during the past six months an order from the Admiralty for the three new-type destroyers, the Erne, Ettrick, and Exe.

No warship work, either of hulls or machinery, being now carried on in Hull, we pass on to the Thames, where we find at the Thames Ironworks at Blackwall that the battleship Duncan built there was delivered to the Admiralty on May 8th, and is now at Chatham having her turntables and guns put on board, which when completed, the vessel will go into dry dock to have her bilge keels, &c., put on preparatory to her steam trials, which will shortly take place. It is noteworthy that of all the auxiliary engines in this ship every one on trial worked most satisfactorily from its being started, without a hitch. The electric machinery also, all of which was made and fixed by the electrical department of the works, worked most satisfactorily.

The Cornwallis battleship, built by the company, is rapidly approaching completion, and will no doubt be delivered to the Admiralty authorities in the next few weeks. Her main engines—made at the company's Greenwich works—are erected on board, and are, with all piping, being now put under the water test. All the boilers are in place, mountings fitted and safety valve gear finished, funnels up and uptakes lagged, and are being closed up ready for testing prior to steaming for the basin trial. The engines of the battleship Albemarle—built at Chatham—are now practically fitted on board; the boilers—of Belleville type—are in place, and erected up to the top of the economisers, and the brickwork is nearly finished. The uptakes will soon be ready to receive the funnels, and the piping in the boiler-rooms is half finished.

Yarrow and Co., at their new Poplar works, have just completed and delivered the eight Yarrow boilers for the cruiser Medea, and three of the same type for the Russian Government training ship Okean. The 31-knot Japanese destroyer Kasumi has been handed over to the Government officials, thus completing the firm's contract with the Japanese Government for the supply of the eight 31-knot destroyers, all of which have safely steamed from London to Yokohama. Some of them have experienced very severe weather without receiving the slightest damage or being in any way strained. A destroyer, 220ft. 3in. long and 20ft. 6in. beam, to steam 30 knots, is in hand for the Swedish Government, and three similar vessels, the Ribble, Teviot, and Usk, each 225ft. long and 23ft. 6in. beam, to steam 25½ knots, are in hand for the British Government. Twelve Yarrow water-tube boilers for a foreign battleship, and a portion of the boilers for another, are also in hand at the Poplar works, the total horse-power being 44,000.

Humphrys, Tennant and Co., of Deptford Pier, have well advanced the propelling machinery and boilers, of 22,000 indicated horse-power, of the armoured cruisers Berwick and Suffolk; the former vessel buil ing at Beardmore's Govan yard, and the latter in Portsmouth dockyard. These vessels are to be fitted with Niclausse water-tube boilers. A set of machinery of 12,500 indicated horse-power, to be fitted with Yarrow large tube boilers for a foreign warship building at Elswick, is also well in hand; together with a set of Niclausse boilers for the war sloops Cadmus and Clio, building at Sheerness. Messrs. Humphrys and Co. will also shortly put in hand a set of machinery of 21,000 indicated horse-power, fitted with combined boilers for the first-class cruiser Carnarvon, building at Beardmore's yard at Govan. The engines of the Berwick, Suffolk, Carnarvon, and the foreign warship in hand at the Deptford Pier works, will all be balanced on the Yarrow, Schlick, and Tweedy system.

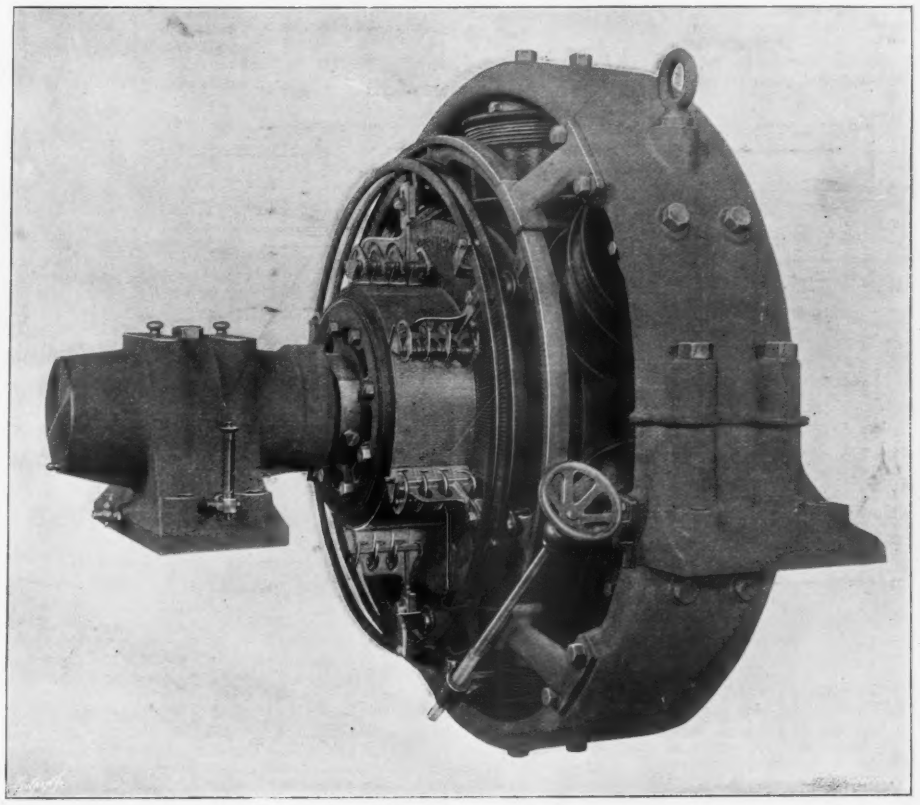
At the Chiswick yard of J. I. Thornycroft and Co. since the beginning of the year, the two destroyers built for the Japanese Government have been completed and delivered. Both vessels exceeded 31 knots an hour in speed on their three hours' official trial, carrying a load of 40 tons. They are each 216ft. 9in. long and 20ft. 9in. beam, and carry the same armament as British boats. The first of them, the Shirakumo, has arrived safely in Japan; the sister ship, the Asashio, is remaining in England to take part in the Naval Review with the Japanese squadron. There are now in hand at the Chiswick yard five first-class torpedo boats for the British Government, similar to the four delivered last year. The first of them will be launched this month. They are each 166ft. long, with a beam of 17ft. 3in., and their designed speed is 25 knots an hour.

Laird Bros., of the Birkenhead Ironworks, have within the past six months delivered the battleship Exmouth at Chatham Dockyard, and she is now undergoing her official trials. The fitting of the battleship Montagu with her propelling machinery is nearly completed and ready for steaming. The two 30-knot destroyers Capitan Merino Jarpa and Capitan O'Brien, built for the Chilian Government, have successfully completed their official trials and sailed. Orders have been received from the British Admiralty for two of the new type of destroyers, to be named the Foyle and Itchen, to have a speed of 25½ knots when fully loaded, and to be fitted with the Laird type of water-tube boiler; also for a third-class cruiser, to be named the Topaze, to be fitted with the same type of boiler.

THE Automobile Club is promoting a 650-miles trial of motor cars in September next. The competitions will be divided over six days, and the start and finish of each day's run is to be made daily at the Crystal Palace.

MULTIPOLAR ELECTRIC GENERATOR

ERNEST SCOTT AND MOUNTAIN, LIMITED, NEWCASTLE-ON-TYNE, ENGINEERS



ELECTRIC GENERATOR.

THE illustration herewith represents the latest type of generator for direct coupling to engines, made by Ernest Scott and Mountain, Limited, of Newcastle-on-Tyne. The armature is of the slotted drum type, with former wound embedded conductors. The core is made up of steel plates mounted on a cast iron centre with driving slots. Cast iron cramping plates are fitted at each side, and these not only serve to keep the core plates in position, but carry the ends of the armature conductors. The commutator is of hard drawn copper insulated with mica. It is bolted direct to the armature core, so that the whole is positively driven, and the shaft can be removed if required.

A number of sizes of this type of machine is made, and the number of poles, which are of steel, varies from four to sixteen according to the size of the machine. The pole pieces are cast separately from the yoke, so that they can be withdrawn sideways, and the magnet coils removed if required, the poles being secured to the yoke by steel bolts. The yoke, as is usual in this type of machine, is in halves.

The brush gear is supported by brackets bolted to the yoke, and the ring supporting the brush holders revolves in these brackets by means of a screw and hand wheel. The brushes are of carbon, and are provided with tension springs and vertical movement.

These machines are designed by the makers so that the temperature rise after six hours run at full load shall not exceed 70 deg. Fah., and so as to be capable of withstanding an overload of 25 per cent. for two hours, or a temporary overload of 50 per cent. for short periods, without sparking or the necessity for shifting the brushes. The finish of the whole is excellent, and there is every appearance that the work is a good mechanical job.

EIGHT-WHEELED SIX-COUPLED TANK ENGINE.

THESE engines—illustrated by our supplement and on page 629—were designed for the heavy suburban traffic in the Bombay district, where trains weighing 145½ tons—empty—stopping every mile for a distance of 10 to 20 miles, require hauling at a high speed. It is therefore essential that they should get away from the stations quickly. The gross weight of engine and train unloaded is 202 tons. These engines have been at work for the past three or four years, and have been all that could be desired, and are economical in fuel. It will be noticed that they are particularly suited for shunting operations, which in this district are considerable. These engines had to be designed to come within the narrow limits of standard dimensions allowed by the Government of India, and by which not more than 15 tons on any axle is permitted.

The coupled wheels are			5ft. 1in. diameter
Trailing radial axle wheel			3ft. 7in. diameter
		T.	c. q.
Weight on leading wheel		14	2 0
,, driving wheel		14	13 0
,, trailing (coupled) wheel		14	12 1
,, rear wheel		13	2 3
Gross weight, empty		56	10 0
Cylinders			18in. by 26in.
Heating surface, tubes			1158·0 square feet
,, fire-box			114·5 ,,
,, total			1272·5 ,,
Grate area			23 square feet
Boiler pressure			160 lb. per square inch
Tank capacity			1100 gallons water
Coal			3 tons

These engines are fitted with United Kingdom gland packing, Holden and Brooke's combination injectors, vacuum automatic brake, and Stone's sight-feed lubricators, and were built by the Vulcan Foundry Company, Newton-le-Willows.

These engines are of special interest just now, whilst so much attention has been given recently to the question of standardisation of engines in India, for the reason that Mr. Luard designed a passenger engine, goods engine, and this tank engine, all of which duplicate with each other in boilers, cylinders, link motion, and axles, and we hope to publish before very long the passenger and goods engines.

DOCKYARD NOTES.

NAVAL review is the topic of the week, and already a week before the appointed day the review was in unofficial progress. Why people crowd so to naval reviews is somewhat of a mystery to many people in naval ports, for there is little worth seeing. The innumerable ships are, of course, interesting, but the ships are usually on the spot for days before and days after the event. It is a pity that Lord Charles Beresford's suggestion for a march past of ships in the Solent could not be carried out, so far as Saturday's spectators are concerned. However, people will flock in their thousands and go away happy, no doubt. Still we would advise those of our readers who look forward to seeing ships as well as a review, to go on some other day than Saturday. None of the British ships, except the London and Sutlej, are of novel interest, but the "foreign museum" is a remarkably good one. It is best visited from Ryde—that is, if anything more serious than glimpses from boats full of excursionists is desired.

THE illuminations at this review will be far superior to those usual. They run for three nights, and on the Thursday and Saturday search-lights will for part of the time replace the lamps that suggest set pieces at Crystal Palace fireworks. These search-light displays will be extremely magnificent, and it is a matter of congratulation to whoever is responsible that the spectacular effect of search-lights on steam is to be used. The plan of colouring the lights is, perhaps, a little too suggestive of pantomime, but it will be very "pretty." Artistically the lights had better have been left natural—for search-lights make their own colours. Still, the artificial colours will, no doubt, prove a boon to the Royal Academy artists who may elect to paint it for next year. Nature's colours with search-lights are not to be found in any paint-box. The best view of the search-light display will be had by taking steamer round the fleet; the ordinary illuminations, on the other hand, will be distinctly better watched from the shore. Of the foreign ships the Pobieda, Montcalm, and Illinois will be the most interesting to inspect.

VICKERS, SONS, AND MAXIM have sent a model of a submarine (Holland type) to the Portsmouth Naval Exhibition. By far the finest model on view is that of the Good Hope, from Clydebank. An interesting point about this model is that ventilating cowls are plentiful in it. In the real ship they are absent; so the fiat against cowls must be very recent. As we have before observed, we think the abolition of cowls a great mistake; but in these days of continual demands for naval "efficiency" we suppose that something must be done of a dramatic nature.

THE INSTITUTION OF MINING AND METALLURGY, SALISBURY HOUSE, E.C.—The Council of the Institution of Mining and Metallurgy have decided to offer scholarships in mining and metallurgy to the following colleges:—The Royal School of Mines, two of £50 each; King's College, London, one of £50; the Camborne School of Mines, Cornwall, one of £50; and the Durham College of Science, Newcastle-upon-Tyne, one of £50. Details will be published later, but in each case the scholarships will be offered annually for three years.

SUGAR MACHINERY.

THE illustrations which we give herewith form a portion of a large order which has recently been completed by George Fletcher and Co., of Derby. That part of the plant which we propose describing consists of locomotive type boilers, juice heater, superheater, and crystalliser. Ten boilers were made in accordance with the drawing which we give on page 625. Four of these boilers were constructed to burn coal, the other six having brickwork furnaces, designed for the burning of green bagassa. The furnace fronts of the coal-fired boilers are also provided with openings, through which they can be fed with bagassa. There are four rings 4ft. 2in. from centre to centre of riveting. The barrel is 7ft. 6in. inside diameter, and it is 18ft. long over the tube plates, which are $\frac{7}{8}$in. thick. There are 116 plain steel tubes, $3\frac{1}{4}$in. external diameter, No. 10 Imperial wire gauge thick, swelled to $3\frac{3}{8}$in. external diameter at the smoke-box end; twelve steel stay tubes, $3\frac{1}{4}$in. diameter, screwed into the fire-box tube plate, and fitted with double nuts at the smoke-box end; and nine steel removable tubes, $3\frac{1}{2}$in. external diameter, No. 10 Imperial wire gauge, having taper collars at fire-box end, and loose taper ferrules at the smoke-box end. These are arranged down the centre, so that when taken out there is sufficient space to admit of a man getting in to clean the tubes, &c. There are also five longitudinal stays. The grate area in the coal-burning boilers is 49 square feet, and the total heating surface is 2452 square feet, 2252 square feet being in the tubes and 200 square feet in the fire-box, which is 7ft. long, 6ft. 10in. wide at the top, and 7ft. wide at the bottom, and 8ft. 3in. high. The working pressure is 80 lb. per square inch. The plates, stays, and tubes are of mild steel throughout. The total length of the boilers over the plating is 29ft. $4\frac{3}{8}$in., and the height from the bottom of the bed-plate to the steam stop valve hand wheel 19ft. $2\frac{1}{2}$in. They are covered with non-conducting composition $4\frac{1}{2}$in. thick. For shipment, the boiler is divided into two parts, faced angle rings being riveted to the ends of each boiler and fire-box, these angle rings being riveted together when the boilers are on the site where they will work. The smoke-box pedestal forms the outlet to a brickwork flue, which is connected with the main chimney shaft, this latter being 160ft. high.

The juice heater which we show in Fig. 1 has been specially designed for dealing with saccharine fluids. The bottom portion is of cast iron and is circular in section, and is fitted with juice inlet connection, run-off valve, and cleaning doors, the bottom having a fall towards the outlet valve. This portion of the apparatus is 6ft. 3in. in internal diameter and about 1ft. 2in. high. The main body is also 6ft. 3in. in diameter and 5ft. 6in. high. It is bolted to the bottom portion by means of an angle ring riveted to it. It is in the same manner connected to the top portion, which is square in plan and just over 7ft. square, and is provided with a gutter at one side, so that the scum which forms on the top of the liquor can be brushed off into and withdrawn by the pipe shown. There are a number of vertical tubes, $1\frac{1}{4}$in. inside diameter, arranged with spaces for the easy circulation of steam on their outsides. The whole of these pipes are not shown on the plan, but their positions are indicated by the intersection of the dotted lines. These heaters are, of course, fitted with steam connections, and are provided with facilities for draining water, &c. The drawing herewith renders further explanation unnecessary.

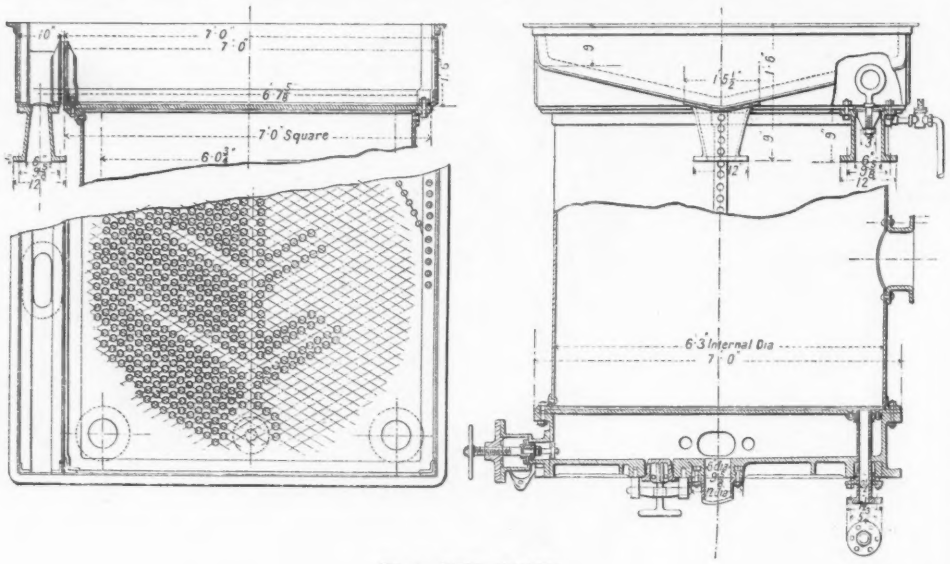


Fig. 1—JUICE HEATER

The superheater used for these saccharine liquors is shown in section and end view in Fig. 2, and in general outside appearance in Fig. 3. The body part is 10ft. between the tube plates, and is made in one piece, the joint being made with a butt strip secured with two double rows of rivets. It is of mild steel, the end plates being constructed of the same material. These end plates are riveted to angles riveted to the superheater body, and they form the tube plates of the apparatus. The inside diameter of the body is 3ft. 10in., and the diameter of the end plates is 4ft. 6in. There are a number of stay bolts screwed into the end plates, and riveted over. There are 76 brass tubes 2in. in diameter, expanded into the tube plates at each end. These tubes are so arranged and provided with connecting pipes, or bonnets, at their ends, that the liquor is passed through them in a continuous manner, while the steam supplied through the inlet at the top surrounds the outsides of the tubes, which are 10ft. long. The bonnets, being secured to the end plates by bolts and nuts, are readily removable for cleaning purposes. The whole apparatus is designed to rest on the four feet riveted to its under side.

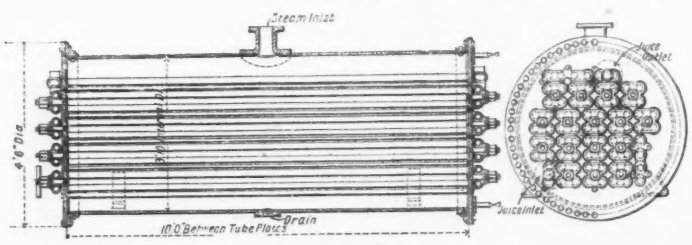


Fig. 2—SUPERHEATER

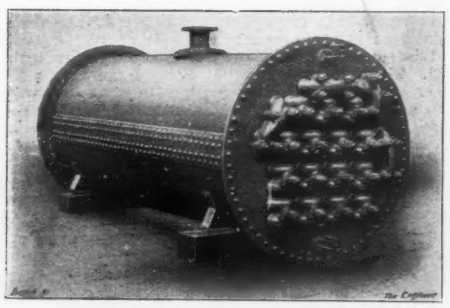


Fig. 3—SUPERHEATER

The form of crystalliser made by this firm for dealing with the massecuite is shown in section in Fig. 4 and in perspective in Fig. 5. It is to this apparatus that the massecuite is taken after it leaves the vacuum pan. Here again mild steel is employed in the manufacture, and the whole apparatus is some 20ft. long by 7ft. 2in. internal diameter. Running from end to end of it is a long steel shaft 5in. square. This, besides being carried in bearings fixed to the end covers of the apparatus, is provided with a third bearing inside and carried on a cross bracket bolted to the sides. The square shaft has mounted on it two spiral stirrers, one on each side of the centre bearing. These stirrers are made of flat bars, and are connected by a number of arms made of flat bar to the shaft, to which they are bolted by U-shaped embracing pieces. Each of the stirrers has a horizontal length of 9ft. 6in., so that the two of them nearly take up the total length of the crystalliser. As will be seen from Fig. 5, the shaft is revolved by means of a worm wheel and worm, the worm wheel being carried on the end of the shaft. The worm, which is carried on a bracket mounted on the end plate, receives its motion from a gear wheel carried by a bearing attached to this worm wheel bracket, and it, in its turn, receives its motion from a pinion on a horizontal shaft, which will eventually work a whole series of crystallisers. The stirring gear makes the complete revolution in four minutes. The stirrer shaft is, at the end remote from the worm wheel, fitted with an arrangement for taking up the thrust of the spiral. The total capacity of the crystalliser is 5223 gallons. Each vessel—and we understand that there are four of them in this particular order—is fitted with two manholes on the top for charging purposes, and on the bottom of each there is a rectangular discharge valve of the sluice type worked with a chain and chain wheel from the ground level. Each also has two thermometers and the necessary steam and water connections.

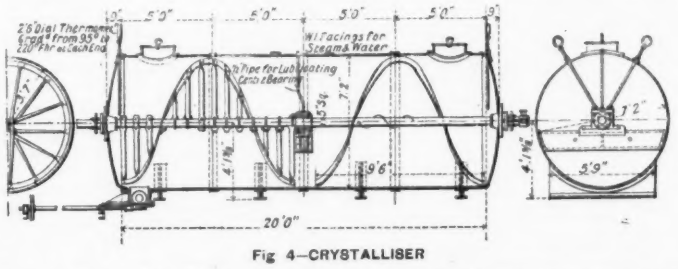


Fig. 4—CRYSTALLISER

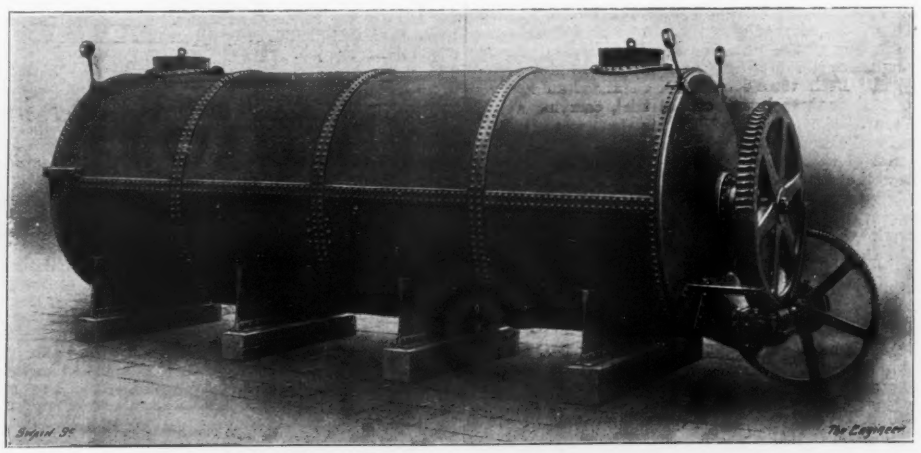


Fig. 5—CRYSTALLISER

NEW PIER AT GREAT YARMOUTH.

THE attractions of this popular seaside resort have been greatly enhanced by the addition of a new pier worthy of the town, which has just been constructed at a cost of about £70,000, by private enterprise, on the site of the old Britannia Pier. The new structure is 810ft. long. The neck, or narrow portion, is 50ft. to 65ft. in width and 610ft. long, and terminates in a parallelogram 200ft. by 144ft. On this larger area a handsome pavilion, capable of accommodating 3000 people, has been provided, surrounded by ample promenade space. For the greater part of its length the pier is carried on steel screw piles with girder supports, all braced together, and at the landing-stage head, where much deeper water was met, logs of Australian Karri wood, 50ft. to 70ft. in length, have been used. This timber has been chosen on account of its powers to resist the marine boring grub, and because, as is well known, it is remarkable for the hardness and density of its fibres. These huge logs weigh between three and four tons each. There are no less than 104 steel piles in the pier, screwed to an average depth of 15ft.; and 200 wood piles, which are driven to an average depth of 22ft.

The pavilion is the work of Boulton and Paul of Norwich, and is estimated to have cost about £15,000. It is bold in design, lofty, and surmounted with both dome and turrets. It possesses interior and exterior balconies, and the walls and ceilings have been tastefully decorated with ornamental plastic work. At the end of the pier is a landing-stage 16ft. wide by 165ft. long. The structure has been built by the Great Yarmouth New Britannia Pier Company, the contractors being the Widnes Foundry Company, Widnes, and the engineers Mayoh and Haley, Norfolk-street, Strand. The new pier will supply a much-needed source of pleasure for the numerous visitors to this bracing resort.

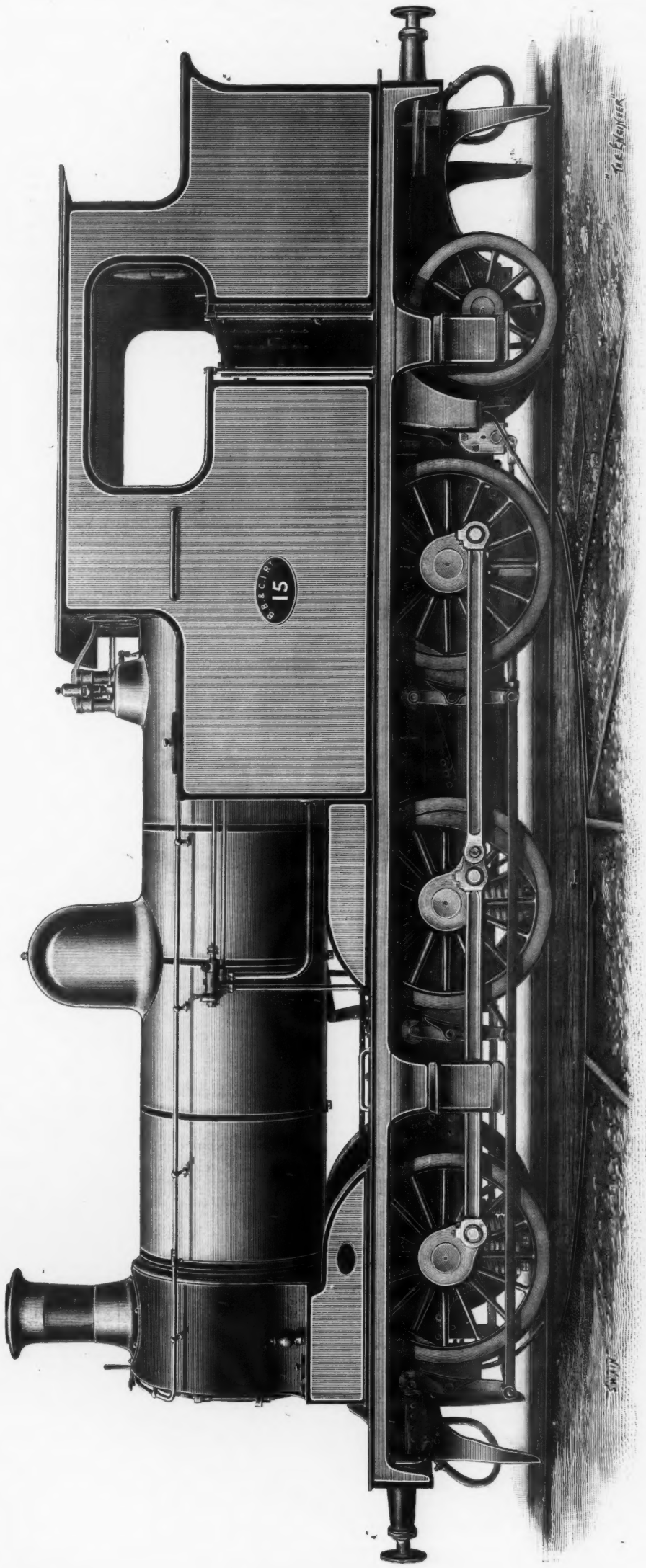
The town of Great Yarmouth is showing considerable enterprise in catering for the patronage of pleasure-seekers. It now possesses one of the finest promenades in the kingdom, and has recently commenced to operate a system of electric tramways. It is well served by the Great Eastern Railway, and arrangements have now been come to by this and other railway companies whereby visitors from the West and Midland counties can reach the town more expeditiously than formerly. We hope that before long the Great Eastern Company will be encouraged to build a terminal station more worthy of the excellent service which it provides.

A SYNDICATE of French capitalists is negotiating for the establishment of a shipbuilding yard in Russia, with a capital of fifty million roubles.

SIX-COUPLED TANK ENGINE, BOMBAY, BARODA, AND CENTRAL INDIA RAILWAY

MR. E. S. LUARD, BOMBAY, ENGINEER

(For description see page 627.)



RAILWAY MATTERS.

THE Burma railways do not issue a guide. This duty devolves on the refreshment contractor, whose time-tables are usually two months after date.

THE Anatolian Railway Company is actively engaged in trying to obtain a concession to enable it to set to work at once with the construction of a small section of the Bagdad Railway for a distance of between 135 and 166 miles from Konia.

THE latest advices from British Columbia state that the Canadian Government has revised its railway policy and will not give any land subsidies, but cash subsidies of from 4000 dols. to 5000 dols. a mile. The Canadian Northern is subsidised to the extent of 5000 dols. a mile.

THE Americans are building railroads faster than the population is growing, though at a moderate rate compared with other prosperous periods. There were but 383 inhabitants per mile of railway in 1900, Europe had 2267, and British India had 12,400. On the other hand, Canada had but 294, and Australia 306.

THE Highways Committee of the London County Council recommend the construction of fifteen new tramways, with a total length of 33 miles, and costing £1,740,000. They also propose to purchase, at the agreed price of £205,000, the whole undertaking of the South London Tramways Company.

THE amount paid during 1901, and to be paid during the present year by the Russian Government as a subsidy to the Eastern China Railway Company for the purpose of maintaining communication between Valdivostock and the ports of the Okhotsk and Behring Seas, will reach the total of £35,200 by the end of the navigation season of 1902.

GIVING evidence the other day before Mr. Compton Rickett's Parliamentary Committee on the London United Tramway Companies' Bill, Mr. Charles Owens, general manager of the London and South-Western Railway Company, said that the section of the tramway company's line already opened had reduced the railway company's local traffic by 64 per cent.

THE Great Western Railway Company announces several alterations in its train service for July, including two new express trains from Paddington to Penzance, both of which will run to Exeter without stopping. There are also to be two new expresses to the North. A number of trains to London have also been put on from various places on the company's system.

A NEW railway speed record is reported from America. On the Burlington and Missouri Railroad a train consisting of nine cars and hauled by a ten-wheeled engine with 6ft. driving wheels, is said to have covered 14·8 miles in exactly nine minutes, or at the rate of 98·66 miles per hour. The section over which the record was taken was between Eckley and Wray, Colorado.

THE Tanga-Korogwe Railway in German East Africa had reached on December 31st 47 miles, and therefore requires but 5 miles to reach Korogwe. There is a daily service between Tanga-Muhesa and back, and another twice a week as far as Muyuzi. Another train runs daily up to Railhead, carrying stores and railway material. The construction of the line progresses slowly.

FROM a return just issued it appears that there are 4317 miles of railway now in course of construction, or likely to be undertaken, in India, of which only 820 miles are in the hands of the State, and 3497 miles are in the hands of companies. Of irrigation projects now in course of construction, there are 994 miles of main canals and branches, and 3073¾ miles of distributaries.

THE Canadian Grand Trunk Railroad is having double lines laid along its entire system where they do not already exist. Eight construction gangs are now at work between Pickering and Bowmanville. The contractors for the double track between Jordan and Niagara Falls expect to have the work finished in September. This will give the Grand Trunk a continuous double line from Montreal to Niagara Falls.

IT is announced from Erivan, the capital of Trans-Caucasia and 110 miles south-west of Tiflis, that a start has been made with the work of extending the Trans-Caucasus Railway from Erivan to the Persian frontier. The projected line will be constructed most probably to Julfa on the river Aras. Russia thus seems to have given up for the present the idea of building a railway from Baku to Resht along the south-western shore of the Caspian Sea.

THE Corean Government has begun to build a line of railway from Seoul to the Chinese frontier by way of Pochyönyan. Some French officers are engaged in the work. The Corean Government has requested the Japanese and Chinese Ministers in Seoul to take steps to remove from Pochyönyan the Japanese and Chinese merchants who have settled there of their own accord and are carrying on trade, although the place has not yet been thrown open to foreign trade.

THE negotiations for the acquisition by the State of the railroads of three of the five Swiss companies have been completed; they are in progress with the Jura Simplon Company. The State's right to acquire the fifth, the Gotthard Railroad, does not begin till 1908. The State pays for its purchase with 3½ per cent. bonds. Nearly all of these are taken in France, the Swiss apparently having better use for their money. The Swiss railroad stocks, however, were largely held in foreign countries.

THE report of the Argentine North-Eastern Railway Company, Limited, for the year 1901 states that the permanent bridges on the eastern branch, Libres to Santo Tomé, have been completed prior to May 1st, 1902, and within the estimates. The gross receipts from passengers amounted to £16,169, as against £13,404, and from goods £35,195, as against £32,725. The result of the working of the line for 1901 shows a profit of £2854 4s. 8d., as compared with a profit of £838 5s. 4d. for 1900. The prolonged drought has unfavourably affected the receipts of the current year.

THE Missouri, Kansas, and Texas Railroad has been conducting experiments in the use of oil mixed with coal for fuel in locomotive boilers, and, according to the statement of officials, the new method has proved highly satisfactory, and plans are now being perfected for its general adoption throughout the whole system. The mixing is done by placing the coal in a large tank and thoroughly soaking it with Beaumont fuel oil, thus greatly increasing the steaming power of the coal. By using oil in this form no changes are required in the fire-boxes of the boilers. The condition of the foot-plate is indescribable.

THE report of Lieut.-Col. P. G. Von Donop to the Board of Trade regarding the accident to a passenger train near Hackney Downs on April 25th has been issued. The report says that the splitting and derailment of this train can be entirely accounted for by the breakage of the axle, and that must therefore be regarded as the original cause of this accident. The fracture in the axle showed unmistakeable signs of a flaw, which was undoubtedly the ultimate cause of the breakage. No blame can, therefore, in his opinion, be attributed to any servants of the company in connection with this accident, but the occasion is taken to point out—as, indeed, has been pointed out before—that it is very unsatisfactory that no method has yet been devised by means of which it can be ascertained whether an axle is structurally perfect throughout. Some methods by which flaws such as that which led to this accident can be detected is much needed.

NOTES AND MEMORANDA.

WE understand that there are now over 1600 members of the Automobile Club.

IN 1899 there were but fourteen boiler explosions reported in the German Empire.

THE total number of entries for the Paris-Vienna motor car race speed section is 205.

PIG iron will only alloy with small quantities of copper, whereas pure iron will alloy with any proportion.

NICKEL steel alloy of 36 per cent. has the least co-efficient of expansion of any known metal, being only $\frac{1}{25}$ that of iron. It is, therefore, specially adapted for the pendulums of high grade clocks; no compensation for variation of temperature being necessary.

THE export of steel rails from Dunkirk increased from 6088 tons in 1900 to 31,322 tons in 1901. This increase was owing to large shipments having been made to the French colony of Cochin-China. As a result of the requirements of the French colonies the exports of all kinds of iron work have increased.

THE influence of the voltage in the formation of ozone formed the subject of a communication to the Paris Academy of Sciences by M. A. Chassy. When the voltage is sufficiently high for the discharge to take place, the author finds that the production of ozone is proportional to the square of the difference of potential which exists between the armatures.

A REPORT worthy of Jules Verne comes to us from America of a Brooklyn inventor who is desirous of demonstrating an aërial coast-defence cruiser, built of aluminium and steel, and weighing nearly 20 tons. It is claimed by the inventor that his airship will have accommodation for a crew of eight men, and could destroy any navy in the world at a distance of 100 miles.

IN 1900, 167 mines in the Westphalian coalfields, employing 226,706 workers, produced 59,000,000 tons of coal, valued at £29,398,000. Of this quantity 57 per cent. was bituminous, 30 per cent. gas, and 13 per cent. anthracite. The average price was about 8s. 6d. per ton, as compared with 6s. 6d. in 1895. The average wage was barely 4s. per day, and the average output per man per annum was 275 tons, as compared with 345 tons in Upper Silesia.

ROUGHLY it may be assumed that the new blast furnaces which will start in the United States this year will produce about 3100 tons daily, and that the plants which are expected to go into operation in 1903 will reach a daily product of 5500 tons. Altogether, in the winter of 1903, the productive capacity of the furnaces in the United States may be swollen by about 11,600 tons per day, or by 4,000,000 gross tons per year. Since the output this year may amount to 17,750,000 tons, this country would have a capacity on entering 1904 of over 21,500,000 gross tons per annum.

THE credit of having reached the highest altitude on record is given to Dr. Bersen and Dr. Suring, of Berlin. They first went up to the height of 30,000ft., losing consciousness for brief intervals. They continued to ascend to 33,790ft., when one of them became completely unconscious, and could not be aroused. The other aëronaut, after making a great effort in opening the valve to descend, also became insensible, and neither of them recovered till the balloon dropped to 16,000ft.

A SUMMARY of the recent prize firing of H.M.S. Terrible at Hongkong has been issued by Captain Percy Scott. The results were below those of the two previous years, and Captain Scott has discovered that this was due to the cordite having been exposed to the sun, and having acquired a temperature of 90 deg. instead of its normal temperature of 63 deg. Hence the muzzle velocity was increased, and many well-aimed shots went over the target. At 1600 yards range the firing was carried out with sights lowered to 1300 yards, and excellent results were produced.

ALTHOUGH June has been generally damp and cold, the average rainfall in Manchester has not been exceeded, and it was reported at a meeting of the Manchester Water Committee last week that the stock of water in the Longdendale reservoirs is not now so large as it was earlier in the month. The rainfall since June 1st over the collecting area was no more than 1·35in. It was also stated that the stock was calculated to be 4,034,000,000 gallons, equivalent to 106 days' supply. On June 5th there was a stock equal to 111 days' supply. This time last year the stock was equal to only 88 days' supply.

IN 1900 the number of persons employed in mines and quarries was as follows:—The world, 4,475,355; the British Empire, 2,883,200; the United Kingdom, 908,412; the United States, 506,830 (returns incomplete); Germany, 733,683; France, 309,815; Belgium, 171,467; Austria-Hungary, 226,330; Russia, 286,983; Italy, 102,728; and Japan, 119,667. The number of fatal accidents in collieries per 1000 persons employed in 1900 was as follows:—Great Britain, 1·29; Germany, 2·19; Austria, 1·08; France, 1·42; Belgium, 1·05; and United States, 3·29. In the United States the death-rate, both in bituminous coal mines and in anthracite mines, is considerably higher than in the United Kingdom.

IMPORTANT trials of a new quick-firing field gun, designed by Vickers, Sons and Maxim, Limited, took place at Eynsford last week. A rate of aimed fire of twenty-five rounds a minute was easily obtained, which gave great satisfaction. Experiments were also carried out with a new 1-pounder pom-pom, arranged for pack-mule transport, the maximum load, including the saddle and harness, complete, being 289 lb. The equipment was unloaded and brought into action in 1 min. 27 sec., after which the programme was carried out, giving a rate of fire of 240 rounds a minute, all the shots being on the target at 1000 yards. After firing the pack equipment was unloaded and re-packed on the mules ready for marching off in 1 min. 15 sec.

A 20-KILOWATT alternator, operated by a Pelton water wheel, receiving its water from the delivery side of the main pumping engine, is a novel feature of the electric plant of the waterworks of St. Louis. This electric plant is an adjunct of the waterworks plant, and furnishes current for the municipal railway extending from the Baden pumping station to the Chain of Rocks and for lighting the several buildings belonging to the Water Department and located in a distance of about five miles along the the Missouri River. It is stated that tests have shown that the Pelton water wheel is so efficient that this generator is operated on a total steam consumption of about 30 lb. per electrical horse-power-hour, which is probably much less than could be obtained with so small a unit by direct connection to an engine.

A SINGLE-PHASE power and lighting plant at La Goule, on the French-Swiss frontier, consists of three turbines of 500 horse-power, and one of 650 horse-power, built by Escher, Wyss and Co., and working under an effective head of 85ft. 3in. Their efficiencies are 79 per cent. at full load, and 80 to 81 per cent. at three-quarter load. The alternators are coupled directly to the vertical shafts of the turbines, and generate at 5500 volts, with a frequency of 50 cycles per second. The longest high-tension line is to the town of Renan, 12 miles distant. There are eleven sub-stations in various towns, with distributing networks to the smaller villages. The charge for private lighting is 1s. 2d. per annum per candle-power, while in factories a charge of 8s. 4d. per annum is made for a 10 candle-power lamp. The charges for motors vary, according to size, from £22 to £13 10s., or less per horse-power per annum.

MISCELLANEA.

TOTTENHAM District Council has decided to purchase a motor combination chemical engine, fire escape, and hose tender.

A SPECIAL electrical engineer is to be engaged from England by the Ceylon Government and the Colombo Municipality combined.

THERE appears to be a good opening in the field of electrical engineering in India. Bombay, for instance, with a population of 750,000, has not yet adopted the electric light, and the tramways are operated by horses.

WE are informed that at the last meeting of the Cycle Engineers' Institute a committee was appointed to consider the possibility of certifying cycle mechanics, more especially repairers, and to report the result of their deliberations to the council.

THE rapid extension of machine mining in the United States is very remarkable. In 1891, it is stated, only 6·7 per cent. of the output of bituminous coal was obtained by the aid of coal-cutting machinery, while in 1900 the proportion had risen to 25 per cent.

WE are informed by Mr. C. T. Crowden that the motor fire engine which he constructed some time ago, and concerning the performances of which some disparaging remarks appeared in the Press, was recently tested severely, and came out of the ordeal successfully.

A SERIOUS explosion occurred last week at the Electric Fuse Works, near Chorley, two persons being fatally, and one seriously, injured. The building in which the explosion occurred, which is distinct from the main erection, was completely shattered. The cause of the disaster is said to have been friction arising from falling detonators. The shock of the explosion was felt throughout the town.

THE non-unionist trouble has reappeared in an acute form in the South Wales coal trade, the Federation workmen of the Cwmaman Colliery, over 1000 in number, having passed a resolution, which has been forwarded to the proprietors, the Cwmaman Coal Company, intimating that unless, within the ensuing week, the non-unionist hands employed at the colliery join the Federation, the unionists will strike work.

THERE is now being exhibited by Tangyes Limited, at 35, Queen Victoria-street, London, an historical relic of the greatest interest and importance—no less than the first locomotive ever made and run in England. It was invented and constructed by William Murdock, the well-known assistant to James Watt, who, second only in importance to Watt himself, invented numerous devices in connection with steam engines.

OUR Manchester correspondent says that the 'Change on Tuesday was altogether unsettled by news of the King's illness and postponement of the Coronation, but it was generally understood that closing of Exchange and works stoppages would have to go on. Moderate business coming forward. Lancashire and some Scotch brands of pig iron advanced 6d.; Middlesbrough a trifle easier; other branches unchanged. Manufactured iron and steel steady at late rates.

IT is stated that there has been an important discovery of coal near Rowley village in Staffordshire, where excavations have been going on for some years. The seam which has been struck is reported to be about 160 yards from the surface. It is calculated that there will be about fifteen acres of first-class coal within the mining estate. The discovery, which has been made only after an expenditure of nearly £20,000, has given the greatest satisfaction throughout the district.

THE new wireless telegraph station erected by Mr. Marconi at Tablehead, Cape Breton, has, according to a Halifax message, now been completed, and the apparatus installed for the proposed Transatlantic service. The feature of the installation is the signal towers, which are 215ft. high. It had been arranged, if possible, to send a message from the new American station to the King on the occasion of his Majesty's Coronation; but it is feared that time is too short to permit of this arrangement being carried out.

IN Chicago it is proclaimed that no electric, steam, or other mechanically-propelled vehicle, while standing in any park or on any boulevard, street, or drive, shall have any of the machinery or generating plant in operation. Further, no person shall cause or permit any such vehicle to emit smoke, vapour, or offensive odours while in any park or on any of the boulevards, and no bell or gong is to be rung or other mechanical alarm given by any occupant of an automobile. A regulation limiting the speed of motor cars to eight miles an hour is also made.

LAST week the United Collieries Company, Limited, issued to its shareholders a statement calling a meeting for July 1st, and announcing that they have entered into a provisional contract for acquiring by purchase twenty-three colliery concerns, principally situated in Lanarkshire. The properties proposed to be acquired have been valued at £2,275,762, and are estimated to be capable of producing a total of 6,000,000 tons per annum, and that there is sufficient proved and readily accessible coal to yield this output for fully thirty years. The total output of coal in Scotland is approximately 33,000,000 tons per annum, so that the company, so enlarged, would produce almost 20 per cent. of the total output.

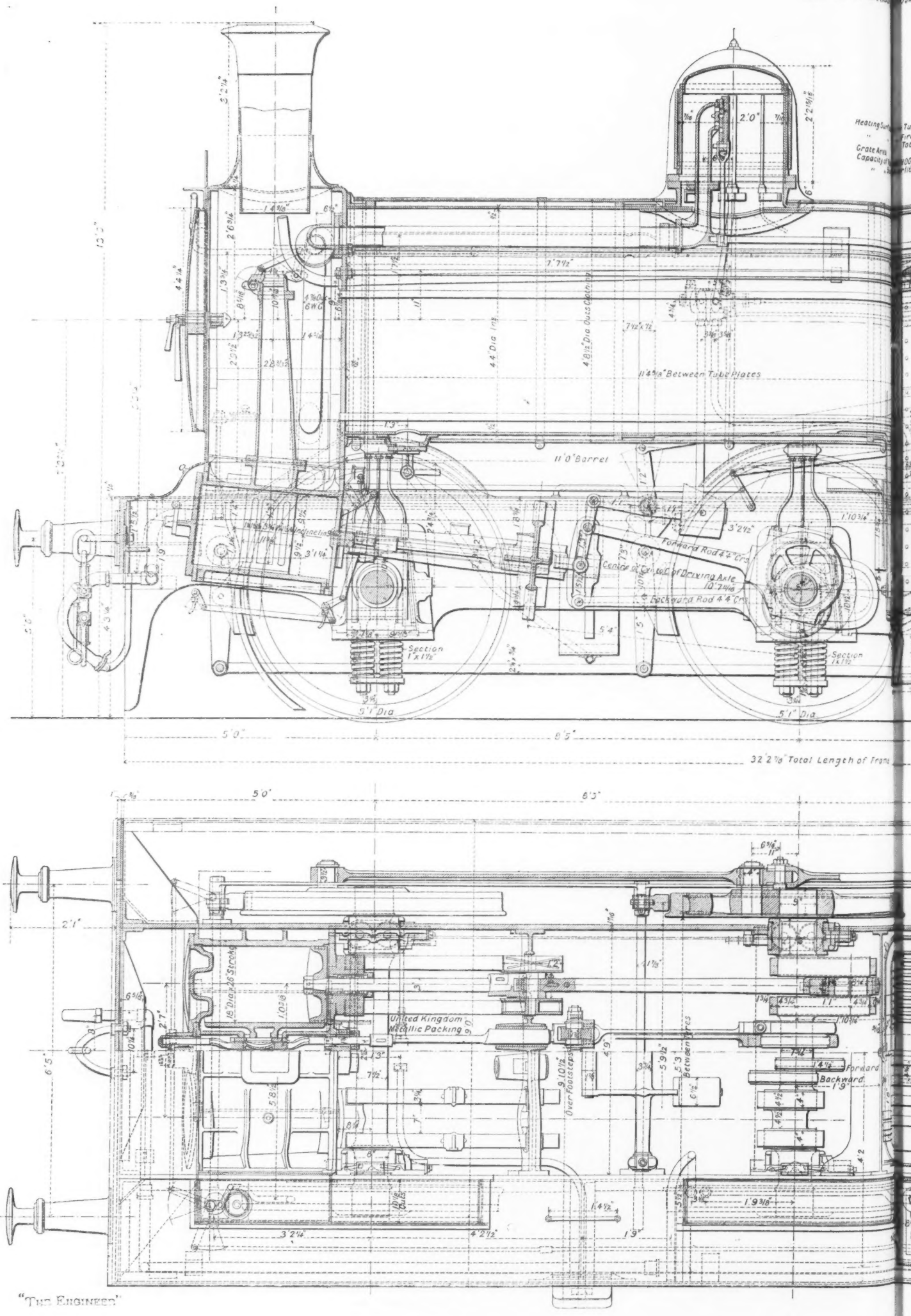
THE Admiralty have issued special instructions to all the recruiting depôts throughout the country, impressing upon the officials the importance of every effort being made to secure desirable candidates for entry in the Navy as engine-room artificers and stokers. As a special inducement to the former branch of the service the number of artificer engineers—warrant officers—is to be increased from 120 to 200. This will mean promotion for eighty engine-room artificers to chief rank, which is to be maintained at a strength of 753, whilst the engine-room artificers will be increased from 2401 to 2546. A large number of additional chief and leading stokers are to be made, and this branch will be increased from 21,963 to 22,927.

THE Telephones Committee of the Manchester Corporation who recently visited Glasgow and made special inquiries with regard to the system of municipal telephony there established, have resolved—"That in view of the approval of the City Council, which has been already given to the establishment of municipal telephony within the Manchester area, and the information now received as to the satisfactory working of the Glasgow municipal telephonic service, it is advisable that the application to the Post-office for a municipal licence on behalf of the Corporations of Manchester, Salford, and Stockport, should be proceeded with, and that all the necessary arrangements be entered into by those corporations with this object."

THE Council of the Institution of Mining and Metallurgy has decided to offer scholarships in mining and metallurgy to the following colleges:—The Royal School of Mines two scholarships of £50 each; King's College, London, £50; the Camborn School of Mines, Cornwall, £50; and the Durham College of Science, Newcastle-on-Tyne, £50. These scholarships will be offered for three years. In addition to the other work for the advancement of technical education in mining and metallurgy the Institution have submitted to the Board of Education a comprehensive scheme for affording practical experience in workshops throughout the kingdom to the mining and metallurgical students and it is expected shortly to be put in force.

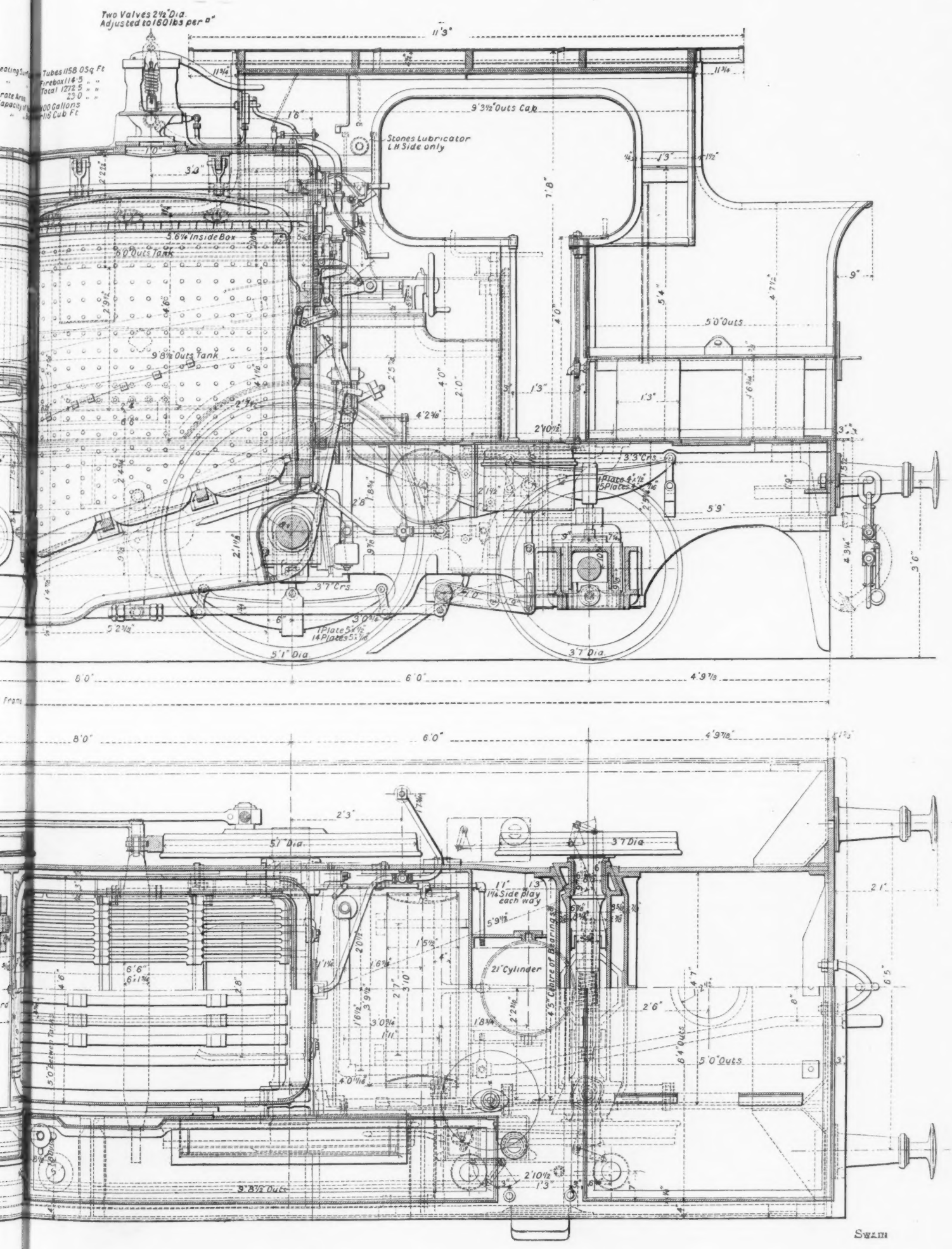
SIX-COUPLED TANK ENGINE, BOMBAY, AR

MR. E. S. LUAR[illegible] OMBAY



AY, ARODA, AND CENTRAL INDIA RAILWAY

, LUAR OMBAY, ENGINEER



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Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and, in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Ten o'clock on Wednesday morning in each week.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

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PUBLISHER'S NOTICES.

*** *With this week's number is issued, as a Supplement, a Two-page Drawing of a Six-coupled Tank Engine, Bombay, Baroda, and Central India Railway. Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it.*

*** THE JAPANESE LINE-OF-BATTLE SHIP HATSUSE.—*Our two-page supplement of the above may be had, printed on Japanese vellum paper, upon a roller, price* 1s., *by post* 1s. 1d.

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☞ *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

A. G. G.—We cannot advise you to go abroad unless you have friends or a little money which you are prepared to lose.

M. P. G. (Leith).—We would suggest that you should write to Allen, Harrison and Co., Commercial-street, Knott Mill, near Manchester.

J. H.—No doubt your case is a hard one. It is possible, however, that matters will come right in the end. We do not publish books, and so are unable to help you.

MEETINGS NEXT WEEK.

RÖNTGEN SOCIETY.—Thursday, July 3rd, at 8.30 p.m., at 20, Hanover-square. Annual general meeting.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.—Seventh Annual Convention, London, July 2nd, 3rd, 4th, and 5th.

THE ENGINEER.

JUNE 27, 1902.

THE PREFERMENT OF PANAMA.

"COMMON sense has triumphed over sentiment, reason over prejudice. The opinion of the country, once overwhelming for Nicaragua, has been revolutionised by arguments, by facts, and business considerations." Thus writes one of the sanest and best-conducted of New York newspapers concerning recent developments of the prolonged, sometimes acrimonious, and often involved controversy regarding the choice of route for the much-discussed American inter-oceanic ship canal. Readers of the two series of articles on this question, the first published in THE ENGINEER towards the close of the year 1900 and the second of which is now appearing, will have received with small surprise the intelligence cabled from the United States during the past few days, and will recognise in the preceding quotation full justification for the views and confidence we have so frequently expressed. It is impossible, under the circumstances, to avoid some measure of personal satisfaction; for, although we may have contributed nothing to the actual result, we can at least claim to have enlarged public knowledge of existing facts and very possible contingencies. Our object has been not so much to protect America from the consequences of an unwise choice as to ensure, in any event, the safeguarding of British interests.

It has been the fashion during recent years to represent the Isthmian Canal question as a matter for the exclusive consideration of the United States, and as one important to the British Empire only in comparatively small degree. A very similar feeling prevailed in this country prior to the opening of the Suez Canal; but of this, thanks to our unrivalled political and commercial influence during subsequent years, there were no evil consequences. He would be a bold prophet, however, who asserted a corresponding issue to the opening of an inter-oceanic ship canal in the Western Hemisphere. The legitimate interests of Europe, and of Great Britain pre-eminently, involved in this enterprise are no less pronounced than those of the United States; and they will be strengthened or jeopardised in direct proportion to the amount of thought devoted to the subject by England, and the degree of her preparedness for the revolution in a very large proportion of the carrying trade of the world, which will be the inevitable result of a maritime highway across the Central American isthmus. The Empire has much to gain, but more to lose, under certain conditions; and it would have been necessary to have taken very careful stock of our position, consequent upon the supersession of the Clayton-Bulwer Treaty, had Congress—instigated either by mistaken patriotism or an idea of overreaching us—committed the stupendous folly of irretrievably associating the United States with the perils and uncertainties of the Nicaragua route.

Thanks to an overwhelming consensus of expert opinion on the other side, and to circumstances which have been or will be discussed in the series of articles now appearing in THE ENGINEER, this danger has been averted, and there is at last, after four centuries of thought devoted to the subject, good prospect that, within another decade, the world will witness the full fruition of Columbus's magnificent discovery. The proceedings of Congress, to which we owe the present situation, call for but brief explanation. It will be remembered that, early in January, immediately after the ratification of the canal treaty with Great Britain, and with contemptuous disregard of the latest findings of the Isthmian Canal Commission, the House of Representatives at Washington reaffirmed the principle that the proposed highway must *ab initio* be American by adopting almost unanimously the so-called Hepburn Bill. This measure empowered the President to proceed immediately with the construction of a Nicaragua canal, and to draw upon the Treasury for that purpose up to 180,000,000 dols. From the House the Bill passed to the Senate, and was by the latter referred to its Committee on Inter-oceanic Canals—a body largely influenced by Senator Morgan, its chairman, and a pronounced advocate of the more popular route. By this Committee the whole question was very exhaustively discussed, and eventually the Bill, in charge of Senator Morgan, was favourably reported to the Senate. It has on several occasions been the subject of warm debate by that body; but it was not until Thursday in last week, after much preliminary skirmishing and lobbying, and many semi-official intimations that the end of an almost barren legislative session was near at hand, that the contending parties risked the arbitrament of a definite vote. The first test of strength was on a proposal favouring the adoption of the Nicaragua line, to the effect that the President should be empowered to order the construction of the longer and more costly canal, should he believe that the interests of the United States would be best served thereby. This was rejected by 42 votes, a majority of 10, and then Senator Spooner's amendment to the Morgan-Hepburn Bill was adopted, first by 42 votes to 34, but ultimately, as a substantive motion, by the more emphatic vote of 67 to 6. Put briefly, this means that the heretofore ill-starred Panama enterprise is to be acquired and completed by the Government of the United States, should it appear to the President that all "rights, privileges, and franchises" needful for placing the canal, during construction and after completion, under the absolute control, management, and ownership of the Republic, can be secured from the New Panama Company, as concession-holders, and the State of Colombia, as owners of the soil. There is little doubt that Mr. Roosevelt and his Cabinet are already convinced on these points, for the company has proved its ability, in fact as in right, to transfer its concessions and holdings by a legal and positive title, "free of all difficulties and contentions, of whatever nature, or from any person whatsoever;" while the Republic of Colombia has agreed to grant to the United States administrative and other rights within the canal region, certainly not less favourable than those offered by Nicaragua and Costa Rica. At the moment of writing, we are without positive knowledge as to the issue of the controversy between the two branches of Congress; but every circumstance points to the conclusion that the House will give way, not only without demur, but even with real satisfaction. Very suggestive of the change which has recently occurred in American opinion are the facts that the Senate Conference Committee includes such unyielding opponents of the Nicaragua project as Senators Hanna and Kittredge, and that their colleague, Senator Morgan himself, has candidly admitted the decisive character of his defeat, and that there no longer exists any alternative to the semi-completed canal between Colon and Panama. Let us hope that the future of that enterprise will belie its past, and that, in the coming years of triumph, the people of the United States will always bear in mind the oft-repeated asseveration that not "exclusive privilege or preferential right," but a sincere desire to see the canal dedicated "to the common use of all nations, on the most liberal terms and a footing of perfect equality for all," summed up the true and fixed policy of the Union as to a trans-isthmian canal.

SUBMARINES FOR THE BRITISH FLEET.

THE submarine seems to have run its course as the daily newspaper substitute for the monster gooseberry. No longer is it a thing of much interest to the man in the street. This, of course, is greatly to the advantage of the submarine, for it was well-nigh impossible to take it seriously when the myth was the staple detail. Now it is to be assessed. There are naval officers who believe that the submarine has a great future; there are others who hold the exact reverse. Speculations in either direction seem to us equally idle. It is of very little moment whether submarines may be the sole warships some two hundred years hence; the only submarine with which we are concerned is the boat of to-day. Is the boat of to-day of any danger or use to us?—that is the question of practical value.

Now, it is fairly easy to sum up approximately the present position. First of all, every boat in existence is an experiment, and to a greater or less

extent a failure. By this we do not mean that any one of them fails in such purely mechanical virtues as being able to sink and rise, steer, move, and remain under water. An ordinary diver can do that; but this does not confer war uses on him. Submarines—or most of them—can fire torpedoes; but a diver is equally capable of attaching them to a ship. We have to look for more than this in order to place the submarine higher than a mechanical toy. Taking the submarine without the gilt and gingerbread, we find that to-day it has the following war qualities:—(1) It can operate within a radius of about twenty-five miles, given a "mother ship" to look after it. (2) By aid of the periscope or some similar device it has some vision in smooth water. (3) By means of the gyroscope or gyroscope and periscope combined it can be steered with fair accuracy upon any point. Judicially worked out, this really amounts to saying that for all practical purposes the submarine to-day is a "Brennan" without controlling wires, which exchanges high speed for a greatly extended radius. Its advocates, of course, claim far more; but till greater speed and, above all, more extensive vision are secured, the submarine at sea must be like the "unmounted man" trying to chase a De Wet. The unmounted man was fully armed for killing the elusive Boer; the trouble was that only by pure accident could he arrive at any spot with his quarry. The submarine is in much the same plight. It is a mole trying to catch a horse—it has to wait for its quarry to come to it. And that is not "war." It is not even "magnificent."

All this, of course, we have in one form or another said before, and we certainly should not return to the subject were this all that we had to say about it. It is not all; we have reiterated this much solely to make our position quite clear in dealing with the latest discovery about submarines. Briefly, this discovery is that "the submarine is the weapon of the stronger power." Hitherto the submarine has been regarded as a defensive weapon, and its use thus detailed. Armed with the idea, we have experimented towards its destruction with some measure of success. Now we have swung round, and are far more interested in pushing forward its limited means of attack. At the same time, our neighbours across the Channel, who till lately cherished the submarine as the special attack-weapon of the weaker fleet, have been diligently seeking a means to destroy it. This, at Toulon, has been done time after time with balloons, from which a submarine was observed without the slightest difficulty, and then "destroyed" by a torpedo boat acting in conjunction with the balloon. The meaning of all this is intelligible enough. However defensively useful a submarine may be inside a harbour, mines, forts, and Brennans already constitute a full defence, rendering the submarine superfluous, if not a direct aid to the attack through the chance that it will entangle itself with the mine field. Outside the harbour it must, save for a very short distance, have its "mother ship." That is all very well, but if the enemy's battleships cannot hold the sea, how is the "mother ship" to do so? It is, in fine, suicide for her to attempt it. Thus at one fell stroke the submarine is robbed of the most important part of its being.

With the stronger power the case is quite different. The "mother ship" can proceed where she likes, and the fortified harbour may no longer be a sure refuge to the weaker fleet. Submarines are cheap, and their crews very few in number. There is no practical bar—supposing the boats available—to the number to be sent in, unless the enemy protect himself with such under-water entanglements as will also shut him in for good. It is urgently necessary, therefore, for the weaker power to find an antidote that shall be practically certain. It is unlucky for the weaker that this new danger for him should lie in the submarine that he has nursed so tenderly, but facts are facts.

Things being thus, there can be little question that the British Admiralty is right in electing to have submarines, because, however imperfect they may yet be, their moral effect may be advantageous to us. Whether in adopting the "sea-going" Holland type it is right, is another matter. For the future it may, perhaps, be wise; but for the present it is, at least, very doubtful. Effectively to use submarines we need many, and—since the command of the sea is tolerably sure to be ours—dependence upon a "mother ship" is no particular drawback. Therefore, it might be wiser to seek out the smallest possible submarine and develop it with the one sole object of harbour attack in view. We cannot but feel that something on the Goubet lines, a small boat of which any warship can carry a couple, would serve better than larger boats that cannot be so transported. The smaller the boat the more easily is she multiplied, while the smaller the crew the less risk is there of panic. We cannot too clearly keep before us that the submarine, even if immune now, will be so for a very short time; the day is bound to come when it will be as vulnerable as the destroyer. This being so, only numbers offer a chance of effective use. This doctrine has curtailed the dimensions of French submarines; ere long it is likely to curtail ours. As yet, however, we have failed to realise properly that the mechanical efficiency of a submarine is of no account against its war uses. For war we will have to use the best tool to hand, not the tool that may be best at some indefinite future date. Most of the failures in war are due to an inability to appreciate properly this distinction.

PETROL ENGINES FOR TRAMWAYS.

NOT long ago the engineer of a light railway in Ireland arrived at the conclusion that he could work some of his passenger traffic to more advantage with a motor carriage than with a locomotive. Some ten or a dozen passengers only wanted conveyance, and it seemed absurd to send a train with a heavy engine a distance of seven or eight miles with so inadequate a load. He made inquiries, and could not succeed in finding a firm who would build the vehicle he wanted. So far as we are aware he has not succeeded yet. It seems to be a little remarkable that this particular class of work has not yet been exploited. We suppose the fact can be explained by the pressure of other business. No doubt a certain amount of experimenting must be done before the best results are obtained, and this for the moment no one cares to undertake.

There is a great deal to be said in favour of the use of petrol engines for working country tram lines and light railways. Twenty horse-power will suffice to give a speed high enough for any tram line on an ordinary road. When we consider how much the resistance would be reduced by rails, it is evident that machinery of not greater power would suffice for the propulsion of a tram car carrying some forty persons. The gradients are not in any way excessive. Indeed, it is difficult to suggest any valid objection to the system. The points in its favour are quite numerous. The cost of petrol is very small. When we remember that a motor car weighing 27 cwt. will carry five persons at fifteen miles an hour on an ordinary highway 100 miles, with 4 gallons of petrol costing 4s., it is easy to see that in the matter of economical working such a car as we suggest would be very hard to beat. It cannot be beaten at all when the number of trips made per day is small. The capital outlay is as nothing compared to the cost of an electrical installation. Unless a road is worked up near its capacity, electricity will not pay as motive power, unless, indeed, water power is available, as in Mr. Trail's line between Portrush and the Giant's Causeway. The motor consumes nothing when it is not earning money, and the outlay for repairs cannot be large. It is well known that the principal cost of running a motor car is the upkeep of the tires. Nothing of this kind would be incurred on a tramway.

One of the great objections to the petrol engine is the noise and vibration which it sets up. It is for the latter reason that pneumatic tires are essential. But in the tramcar it would be quite possible to use ordinary railroad wheels with steel tires, and the engine could be so cut off and isolated with india-rubber pads and springs that no vibration would reach the car; on many roads only one speed would be required, on still more two would suffice. The number on which three speeds would be necessary must be very small indeed. The vibration so objectionable when a car is standing could be entirely avoided by the use of the electric starter now coming into favour. It is with its aid no longer necessary to keep the engine going when the car is standing, to avoid the trouble of using the starting winch. We cannot think that any firm which has had experience in building motor cars would have the least trouble in designing a tram car which would satisfy every requirement. Even if objections were raised to the explosive engine, it would be easy enough to produce a steam car, using liquid fuel, which would do excellent service.

Apart altogether from tram lines, there is another use to which the motor car could be put which might well commend itself to railway companies. There are not a few places in the country now which are stations from which short branch lines run. It often happens that three or four passengers would fain use this line, but cannot do so because the last train, let us say, has gone. The station can be reached by the main line, and there the journey must end unless the travellers hire a carriage. At such stations there might be provided a light railway vehicle propelled by a petrol engine, and this could be sent away as a "special" at any time at very small expense. Again, not a few railway stations are a mile or so from the town from which they take their name. The railway companies have not found it pay to run horse-drawn vehicles between the town and the station. They ought to have no difficulty in using a suitable motor car for the purpose.

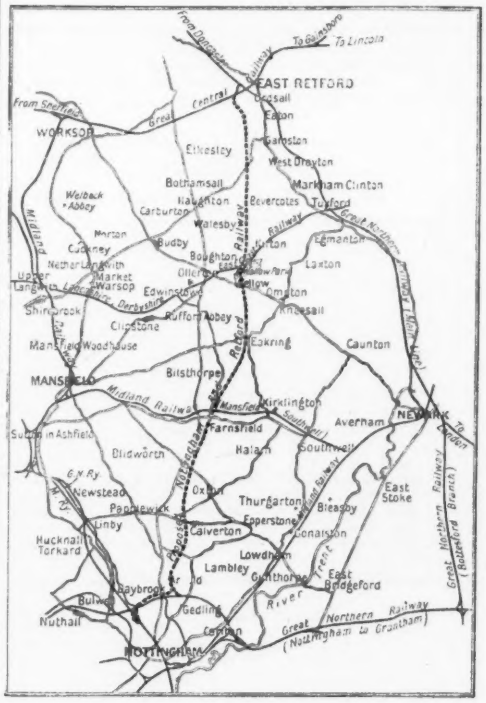
At the present moment electricity is carrying all before it as an agent for propelling public vehicles. There is, however, undoubtedly a large field in which the petrol motor could be applied to far greater advantage than any other mechanism it seems possible to devise. Nothing whatever worth the name has been done in this direction. Indeed, we fancy that the cars running between Hastings and Bexhill represent, with very few exceptions, the only omnibus service by petrol engines in this country. Omnibuses of the kind have been tried in South London, but they have for some cause not succeeded. We cannot cite a single case in which petrol is in use on a tramway. The time is, however, coming, and we venture to hope that it will not be left for the American or the German to teach us how to extend the use of petrol in this direction.

NEW RAILWAY FROM NOTTINGHAM TO RETFORD.

THIS proposed new railway is 30 miles in length, and since the rejection of the London and Brighton Electric Railway, with a length of 47 miles and a capital of £12,000,000, holds the record for mileage in Private Bills of this description in the present session. It may be stated that the Sheffield, Rotherham, and Bawtry undertaking ran it rather closely with 27 miles, but as the preamble of this Bill was declared not proved, there is for the present an end of it. The Great Northern Company's Bill, which seeks for powers to make certain new lines in South Yorkshire, and to spend £2,000,000 upon 25 miles, is well advanced, having passed its third reading. The Bill for the Nottingham and Retford Railway is passing through Parliament as an unopposed Bill, and was read a third time in April last. It petitions for the incorporation of a company to construct a line between the above-mentioned towns, and to form junctions and connecting lines with the Great Northern, Great Central, Midland, and Lancashire, Derbyshire, and East Coast Railways.

The route of the new line will be seen from the accompanying map. It makes a direct connection between the town of Retford and the capital of the county, and thereby greatly improves the existing intercommunication.

The line itself commences at Nottingham by junctions with



NOTTINGHAM AND RETFORD RAILWAY

both the Great Northern and Great Central Railways, and passing to the east of the village of Arnold, and tunnelling under Dorket Head, emerges in the Calverton valley. From this point, proceeding over an undulating country by alternate cuttings and embankments, it passes a short distance to the west of Calverton, and crossing the Nottingham and Oxton road near Watchwood Farm, continues in a more of less direct line northwards, past Salterford Dam to Farnsfield. Crossing the Manfield and Southwell line of the Midland Company near Farnsfield Station, the line passes under Eakring Brail Wood to the village of Eakring, and proceeding to the west of Jordan Castle Farm, it is continued by another tunnel under Wellow Wood, emerging on the other side near the Lancashire, Derbyshire, and East Coast Railway, which it passes over, and from which point it passes between the villages of Boughton and Kirton to Walesby, and thence past Elkesley to a junction with the Great Central Railway immediately to the east of Retford Station.

The line is being promoted by the large landowners through whose estates it passes, with the intention of developing the very important coalfield which is believed to exist under this portion of the county.

The engineers for the construction of the new line are Messrs. Edward Parry and F. W. Bidder, MM. Inst. C.E., to whose courtesy we are indebted for the above information and plan of route.

PEAT FUEL WORKS, STANGFIORDEN, NORWAY

THE MANUFACTURE OF PEAT FUEL BY THE AID OF ELECTRICITY.

ALTHOUGH electricity is not generally regarded by engineers as an economical heating agent, its use for this purpose in many industrial operations is increasing. This advance is due to the fact that by aid of electricity the heat can be generated exactly at the spot where it is to become effective, and that the losses arising from radiation and conduction are therefore reduced to a minimum. Even where only moderate temperatures are required, there is much to be said in favour of using electricity, and when the generating costs are exceptionally low, the actual cost of the heating operation compares favourably with the cost of heating by coal.

The latest example of this use of the electric current is in the manufacture of peat fuel. Nearly every country of Europe possesses immense peat bogs and morasses, which are as yet practically unutilised for industrial purposes. Peat moss litter, and peat fuel, have so far been the chief manufactured products. Natural peat fuel has only been used, in fact, in special cases, where no other fuel was available. The difficulty in obtaining a satisfactory fuel substitute from ordinary peat is due to the immense amount of water which it contains in its natural state. The percentage of water runs up to 80 and even 85 per cent., and, of course, has to be removed before the remaining 15 per cent. of solid carbonaceous matter can be rendered available for fuel purposes. Many methods have been devised for removing portions or whole of this water, and for the manufacture of a satisfactory peat fuel. Some of these processes have been industrially operated, and have yielded fairly satisfactory results.

The process which is about to be described differs from all earlier ones in the use of the electric current for carbonising the dried peat in retorts of special design. It is the invention of P. Jebsen, of Dale, Norway, and the process is patented in Norway and in other countries. The process has been in actual operation at Stangfiorden, Norway, since 1898, with favourable results. The plant at present installed deals with 1000 centners air-dried peat per day. The process yields a dense and compact mass after the heating in the retorts. The specific gravity of the carbonised fuel in the broken condition is about ·30, and the theoretical calorific value about 7250 thermal units. The fuel burns well and yields little soot or ash. An analysis of the products, made by the authorities at the Konigl. Norweg. Hochschule in Christiania gave the following mean composition :—

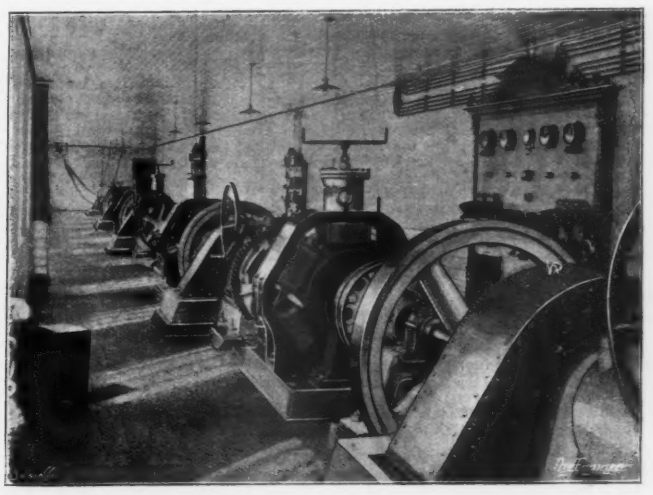
	Per cent.
Carbon	76·91
Hydrogen	4·64
Oxygen	8·15
Nitrogen	1·78
Sulphur	·70
Ash	3·00
Moisture	4·82

The power required for carrying out the Jebsen treatment at Stangfiorden is derived from five 80-kilowatt dynamos direct coupled to five turbines of equivalent—128 horse—power. The power generating installation was provided by Schuckert et Cie., of Nuremburg. The wet peat is brought to the factory direct from the bog by water, in lighters of about 100 tons capacity. The boats are discharged by aid of mechanical power, and the peat is submitted to the first drying and pressing operation. This is carried out in a 5 horse-power press which can turn out 2500 pressed blocks of peat, each measuring 80 by 8 by 8 cm., per hour. The average weight of dried peat in each of these blocks is 2 kilos.

The briquettes of pressed and partially dried peat are next loaded into trolley shelf wagons specially designed for tunnel drying by an American company. Each wagon carries, when fully loaded, 140 of the wet briquettes arranged on ten shelves. The trolley wagons are pushed, when loaded, into the cooler end of the drying tunnel. The air draught which passes through the tunnel is set in motion by fans electrically operated, and is heated by the waste gases from the retorts. The air has a temperature of 90 to 100 deg. Cent. at the top end of the tunnel where the wagons emerge, and one of 40 to 50 deg. Cent. at the lower end where they enter. As the wagons pass up the tunnel, the peat is, therefore, submitted to a gradually increasing temperature. The drying plant at Stangfiorden comprises one hot air stove, three electric fans, two tunnels, and 102 shelf wagons; 1000 centners of air-dried peat blocks can be produced per day. The wagons with their charges of dried peat are next taken on tram-rails direct into the retort house, and are emptied directly into the retorts.

The retorts are upright cylindrical vessels of iron, about 2 m. in height and 1 m. in diameter. Each retort has a removable cover, and a discharging hole below, and is in addition provided with gas exit pipes and a pressure gauge. The retorts are provided with spiral resistance coils of special construction, and the blocks of peat are built up in actual contact with these, until the retort is entirely filled with a pigeon-holed mass of peat, in the centre of which the heating agent lies. The top cover of the retort is now clamped down, and the electric current connections are made. Losses by radiation are minimised by lining the retorts with asbestos. The peat yields three products when submitted to this electrical heating in closed retorts. The gaseous products pass away by openings in the retort cover, and after scrubbing are

THE RETORT HOUSE



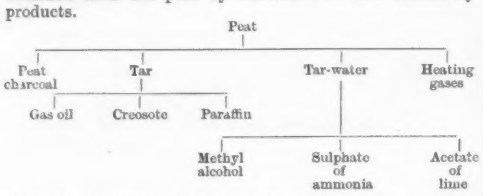
THE DYNAMO HOUSE

employed for heating the air used in the drying tunnels. The tarry liquid condensed in the gas pipes and in the scrubbers contains tar oils, ammonia, and other compounds, and if the plant and technical skill are available, may be worked up for these products on the spot.

The peat fuel remaining in the retort after the carbonising operation is completed is allowed to cool down to 130 deg. Cent. before opening the retort, and is then discharged direct into wagons running beneath the retorts. The peat fuel produced at the Stangfiorden factory is shipped direct to Bergen, where it is said to meet with a ready sale. The average yield of 100 kilos. of the air-dried peat at Stangfiorden is as follows :—

	Per cent.
Peat fuel	33
Peat tar	4
Tar water	40
Gaseous products	23

The diagram below shows the final products which are obtained from the peat by treatment of the various by-products.



For the photographs which illustrate this article, and the information upon which it is based, we are indebted to B. Horsky, of Prague, the European agent for the Jebsen patents. We understand that negotiations are in progress for the introduction of the Jebsen process into Ireland, in connection with the development of one of the water-powers on the West Coast.

SWEDISH WARSHIPS.

THE Swedish Ministry of Marine has just prepared the final specifications of an armoured cruiser, which will form a new type of vessel for the navy. The parliament has voted the money necessary for building the projected warship, and its construction can be begun at once. The cruiser will be protected by Krupp armour plates. These plates will be from 125 mm. to 50 mm. thick in the conning tower, and 100 mm. in the barbettes and at the water-line, while the deck plating will be from 50 mm. to 37 mm. in thickness. The armament will consist of eight 15 cm. and of fourteen 57 mm. quick-firing guns, with two torpedo-discharging tubes. With a displacement of 4060 tons the cruiser will have a length of 115 m. on the water-line, a beam of 14·9 m., and a draught of 4·9 m. At full steam with 12,000 horse-power the cruiser is to attain a speed of 21½ knots. The cost of construction will amount to about £350,000, and the vessel will take rather more than two years in building. The Swedish navy is about to have a new type of submarine boat of the following dimensions :—The length is to be 20 m., and, when submersed, the displacement will be nearly 120 tons. Its speed above the water is to be 10 knots, and it is estimated that below the water it will make 7 knots. This boat will be equipped with 45 cm. torpedoes.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

ENGLISH *versus* GERMAN STEEL.

SIR,—Apart from the question of price, German steel is very largely in use in this country on account of its superior finish. There is no doubt that originally it may have found its way into certain works because of the scarcity of obtaining English material at anything like a reasonable price, but once having got there, there is no question that the English article will never again in its present form be accepted. Apart from the question of joists and channels, for which they have peculiar facilities in a greater variety of sections over and above the English makers, and this may in some degree account for the large portion they have of this market, there is a question of bars, angles, flats and sections.

Take first of all bars. With one notable exception, you cannot in this country obtain steel bars of the finish that you can from Germany. They are nothing like so well rolled, the edges are not so square, neither are the bars so correct to size. In addition to this, the same holds good, as will be seen later on, that the bars are sent in much straighter, and cut off much more exact than any bars that you can get in this country. In works of a limited area, where space is of importance, it is very necessary that stock should occupy the least possible space. You can certainly load 25 per cent. more of German bars into the same space than you can English bars, for the simple reason that the English bars not coming straight, occupy far more room. If it is asserted that a great deal of the reason for this is that German steel is produced by the basic process, my answer is that in a great many cases it is of very little importance as to what process the steel bars are produced by. A great deal of work may possibly require a special grade of material, but it is far more important that the material should be well rolled.

Coming to the question of angles, these are certainly sent in worse in this country even than the bars, compared to Germany. Lately I had a 10-ton parcel of 3in. by 3in. by ½in. angles which were delivered in such a state that it was practically impossible to put them on to any rack, and the whole of them had to be straightened by hand before they could be used or even put into stores. I have now sent a repeat order for this quantity and size, with an intimation to the works that they must be sent in straight, or they will have to be declined. I am then coolly informed that there will be an extra for cold straightening. I can only say that in my business experience I have never known a German firm to ask extra for cold straightening, and certainly the price of the German angles is not more than, and in most cases considerably less, than that of English makers. This occurred with one of the best-known firms, and really the state in which they were delivered was an absolute disgrace. Add to this, the angles are nothing like so well finished, either to section or size. The ends are sawn off hot where the Germans are sawn off cold, and as far as quality of material is concerned, we have no difficulty whatever with the German angles.

Coming now to the question of plates, this is exactly the same as the question of angles, with this difference, it is still further in favour of the German plates. We have to pay in our works 25 per cent. more for straightening English plates, owing to the much worse state they are delivered in respect to buckling than the Germans are, and further than this, they are harder, and they are not sheared anything like as exact to size as the German. I have just received 10 tons chequered plates, English, quoted at a certain price for ¼in. I asked the maker to roll at 11 lb. He said he could not, but would at 11½ lb. for an extra of 10s. per ton. I also informed him that the chequers must run continuously. He said he should require a ⅛in. over margin over the size required. This I agreed to. Now the plates come in, they are 25 cwt. over weight, and maker declines to make the allowance.

Lastly, all that has been said in reference to plates, angles, and bars is intensified when one comes to deal with the question of sections, which may be made to special requirements.

In the first place, the cost of rolls is possibly greater in Germany, as an initial first cost, than in England, but immediately the rolls are in existence, it seems to be an accepted rule in this country that the maker is to immediately "bleed" the consumer, as he seems to feel that having the rolls he can command the price, oblivious of the fact that the customer, having paid for the rolls, should receive a concession over the price of material where the maker has had to pay for his own roll. In Germany exactly the reverse occurs. After the rolls are in existence, we have invariably found that we have been treated absolutely fairly in reference to price of material. No consideration that the rolls are in existence seems to weigh with the German manufacturer in arriving at his price. In the second place, the German will take sections which the English absolutely asserts cannot be rolled ; not only that, he will turn them out in a way which puts to shame any maker in this country. One of the great difficulties that we have to contend with in sectional steel is bad rolling. I do not for one moment say that the German makes no bad material, but I do say he does not send it to his customer, whereas the English manufacturers seem to take a delight in getting a lot of his defective bars off on to his customer, with the hope that they will get through without being noticed. Some time ago we had such a very bad lot of English bars that we complained more than usual. The maker sent his foreman down to our works, and after having seen us and endeavoured to get us to use them by suggesting that certain portions of the bars might be used, and the rest "scrapped," he intimated that possibly the man who had to use the iron, if he were allowed to see him, would pass the matter without saying anything further to us. I unhesitatingly state that a considerable portion of every delivery of section steel is more or less defective. No doubt a great deal of this is owing to carelessness on the part of the roller, but surely there is a necessity for a careful examination of all work before leaving the works, when this would be avoided, and possibly greater care exercised in the future. I met one of the largest iron rollers in this country of these sections a few days since, and discussed with him the question of English *v.* German in this respect, when he coolly informed me that he could not expect to compete with the Germans, except at £1 per ton over their price, and really thought he was justified in asking this price on account of, amongst other things, the prompter delivery that one has when getting in this country, and he thought that patriotism ought to be considered in a transaction of this description.

There is one other peculiar point in reference to these sections. While the English maker is constantly grumbling at the lightness of the section, the German is always asking that the section may be kept as light as possible, and further than this, we notice that whereas the English sections gradually get heavier as the rolls are trimmed, the Germans do not. I am rather led to believe that the Germans do not produce their sections in the same way as the English do, and this may in some way account for this.

I am rather afraid that you may consider these statements of the superiority of the German over the English to be exaggerated. I do not think, however, that the English manufacturer goes to the German for his material for any love he has of the Germans, nor do I think he would go there if he could obtain in this country what he wanted, even at a small increase over the German price, but £1 per ton is very often a profit ; and in reference to the statements made in this letter, I shall be very pleased to submit to you samples of the respective work turned out by England and Germany. I shall also be very pleased to show you parcels of each lot of material. I am also quite prepared to submit to you the invoices of each for your comparison and confirmation. I can only say that so far as I am personally concerned I would far prefer to buy in this country.

I have not had the pleasure of going through any German rolling mills, but I have English, and I am not surprised that material is sent out in the way it is. I am only surprised it is not worse.

X.

June 20th.

THE BRITISH FIRE PREVENTION COMMITTEE'S NEW ARRANGEMENTS FOR BUSINESS MEN.

SIR,—The terrible fire in Queen Victoria-street—following so shortly upon the Hackney fire, where seven lives were lost, and upon the Barbican conflagration, where so much property was destroyed—has led many City firms to communicate with the British Fire Prevention Committee, either for the purpose of mutual co-operation, or with the view of obtaining advice, and we hence inform you that special arrangements have now been made by which the industrial and commercial establishments of the metropolis can benefit from the results of the Committee's investigations, which have so far only mainly served the purpose of assisting the members of the technical professions.

A special industrial section—the scheme for which has already been under consideration for some time—has now been started in connection with this Committee, and is open to all firms of ordinary business standing, as well as to responsible representatives of such firms.

The main objects of the Fire Prevention Committee—as we believe is generally known—refer primarily to the protection of life and property from fire by the adoption of preventive measures. The Committee uses its influence in every direction towards minimising the possibilities and dangers of fire, to bring together those scientifically interested in the subject, and to arrange periodical meetings for the purpose of discussing practical questions bearing on the same. The Committee's scope includes independent testing of fire-resisting materials, methods, and appliances, no less than sixty of such tests having been undertaken since its incorporation. Papers on the subject are published periodically, no less than sixty-eight of the Committee's Red-books having been issued.

To meet the particular requirements of business men with regard to the better protection of life and property from fire, the special industrial section now formed will mainly deal with every-day practical requirements of the community rather than with the research side of the question, and the programme of this industrial section may be summarised as follows, namely :—(1) To assist the movement for better fire protection inaugurated by the Committee, having special regard to the advantage of practical preventive measures. (2) To bring together those interested in the management of offices, works, factories, mills, refineries, warehouses, &c., in order that special facilities for obtaining immediate information shall be available to all concerned : (*a*) as to the requirements of public authorities ; (*b*) as to approved methods of construction and equipment ; (*c*) as to tests or experiments with fire-resisting materials or fire appliances ; (*d*) as to the experience gained at actual fires ; and (*e*) as to the organisation of fire watches, private fire brigades, &c. (3) To afford facilities for combined action in respect to the requirements of the public authorities. (4) To arrange periodical meetings for the purpose of discussing practical questions bearing on the subject, to publish and distribute such papers as are of special interest to members of the section, and to form such collections of models, appliances, records, and statistics, as may be useful for reference. (5) To issue periodical warnings and notices to members calling attention to specific risks or safeguards.

Each firm joining the section will be represented by one representative, who shall either be a principal, a director, manager, secretary, or skilled adviser to the firm in question. Individual principals, directors, &c., are, however, eligible as members quite apart from the membership of their firm, but at no time shall more than three members of the same firm belong to the section, and for all resolutions relating to the business of the section no one firm shall have more than one vote.

The annual subscription for every firm or individual becoming a member has been fixed at two guineas per annum ; but for any individual member whose firm is already associated with the section the subscription will be one guinea per annum. The Committee's auditors include Mr. James—Messrs. James and Edwards—president of the Institute of Chartered Accountants, and all members of the Committee give their services voluntarily.

The section will elect its own chairman and vice-chairman, who will also have seats on the Council of the General Committee, where they will represent the section in all matters relating to its particular interests.

We think that the scientific side of the Committee's work has been successful, and of value for the members of the professions for whom it was originally mainly intended, and we hence trust that the many City firms interested will also now be able to likewise benefit from practical application of the Committee's labours.

We believe that if the business men were to look upon questions of safety from fire in the same way as they realise the importance of attending to questions of hygiene, they will soon—partially by self-help and partially by using their influence with the authorities—be able to rely on that measure of security, both for life and property, as they to-day enjoy, and are officially safeguarded against, in respect to bad drainage and its effects.

EDWIN O. SACHS, Chairman.
ELLIS MARSHLAND, Hon. Secretary.

Offices of the British Fire Prevention Committee,
1, Waterloo-place, Pall Mall, S.W., June 16th.

STEAM.

SIR,—I am very glad that my article published in your issue of May 30th has called for the admirable reply of "R. H. M." in your last impression. It is not often that we find a competent man writing to dispute statements which constitute the tenets of the orthodox faith of the writers of text-books. For the moment I shall confine myself to only one portion of "R. H. M.'s" article, namely, the last paragraph of the central column, on page 600, beginning with the words, "And now comes in another curious unexplained phenomenon, when a large amount of the *latent heat necessary for the formation of steam* is obtained."

I take the words I have put in italics, and I ask "R. H. M." what they are intended to mean? I suppose he has formed some concept on the subject, the nature of this concept will affect the whole of his reasoning. In one word, unless he is prepared to cast all existing theories to the winds, that cannot take place which he seems to assume does take place. The accepted theory is that there is no such thing as "latent heat." Water rises in temperature to 212 deg. It becomes no hotter after that. At atmospheric pressure it does not accumulate heat, all the heat which it subsequently receives is converted into work. That is to say, in driving the molecules of the water apart and putting them into motion as a gas. This being so, it is clearly impossible that, unless steam is made, any heat can become latent. There can be store of latent heat anywhere present in the whole body of heated water. That is to say, I, at all events, find it impossible to form any concept of heat imparted to water and producing no effect whatever, neither raising the temperature nor making steam. This is just one of the difficulties which I raised in my article of May 30th. How does steam obtain its heat, or more accurately, its energy out of water which apparently does not contain it? "R. H. M." appears to beg the whole question. He takes it for granted that water can contain all the energy needed, and yet make no sign.

As this is a very crucial question, and I may have failed to understand him, I venture to hope that he will define with more precision just what his words are intended convey.

As so much has been said about the molecular and atomic theories, it will not be out of place if I refer here to a difficulty which seems to have escaped "R. H. M." It is assumed that pressure is due to the impact of molecules on the sides of the containing vessel. The surfaces of the metal must be either absolutely elastic or absolutely hard, otherwise energy will be lost. If the walls are absolutely elastic and the molecules absolutely hard, the conditions of the conservation of energy will be satisfied. If both are absolutely elastic the same end will be secured.

Now let us admit for the moment that the oxygen gas shut up in a cylinder is absolutely elastic ; it is certain that the steel cylinder is not. In effect, therefore, there must be a loss of energy manifested as a loss of pressure. Experiments have, I believe, been made by keeping such cylinders over very long periods ; but no loss has been detected, the proper initial conditions of temperature being satisfied.

To get over this difficulty the more advanced scientists now maintain that contact never takes place between the walls of a gas cylinder and the metal ; the latter is lined, so to speak, with a coating of ether, and this being perfectly elastic, the theory is satisfied. Another view is that although steel as a metal is imperfectly elastic, each molecule is quite hard, and that it is not with the steel as such that the gas molecules come in contact, but with these rigid molecules. It is obvious that if this kind of reasoning is admitted as legitimate, almost any explanation of physical facts can be evolved out of the inner consciousness.

Westminster, June 20th. B. T. U.

SIR,—There is one point which has not been referred to in the matter of the boiling of water in the presence of grease. I allude to the boiling of water in the open air in a well-oiled vessel. Every one who has fried a chop knows that ebullition under these conditions always takes place with explosive violence. I have recently had a small steam engine under test in the cover of which there was a small cavity—on the outside—which became thoroughly greasy and afterwards filled with water from a leaky gland. The result was that it was positively dangerous to one's eyes to go near it. All the water in the cavity boiled out in a series of small explosions which scattered the water all over the test shop. This effect seems to be produced when several substances that will not mix are boiled together. For instance, if a drop of mercury is put into a crock of boiling water all the water will be blown forcibly out of the crock. I have never actually seen this done, but have had it from several independent sources in South Africa, where, in the early Barberton days, it was a very favourite trick to drop a little mercury into the crock in which a man was boiling his supper, and watch the whole contents of the pot go skywards.

It would almost seem, therefore, that the boiling of any two non-mixing liquids with different surface tensions results in explosive ebullition.

J. S. V. BICKFORD.

Camborne, June 16th.

FAIRLIE ENGINES.

SIR,—I was interested to read in your issue of 16th ult. the illustrated description of the new design of Fairlie locomotives for the Burma Railway Company, but am sorry to say it seems to me to be a decidedly retrograde step in the evolution of the Fairlie type. I had some years' experience with Fairlie locomotives in South America, and designed an engine of the Meyer type, which proved to be better in every respect. Three locomotives were built, and a short description, with the comparative results obtained I gave in a paper on "The Tocopilla Railway," read before the Institution of Civil Engineers in 1899—*vide* "Proceedings," vol. cxlii., 1899-1900.

The chief novelty in the Fairlie locomotive you describe is the

separate boilers. This I considered seriously at the time, but abandoned as introducing serious disadvantages and no real advantage. I much prefer two separate locomotives designed to couple together and form one footplate, the regulating and reversing levers being coupled together. The advantage pointed out of being able to work part of the train in the event of one boiler failing remains, and also the disadvantage of possible difference in steam pressures in the boilers, with the consequent unequal working of the engines.

A minor defect, I see, is perpetuated in having the ball joints of the steam pipes so far from the centres of the bogies. By keeping them close to the centres the movement is so slight that there is very little wear, and they give absolutely no trouble, and very seldom require re-packing.

The following comparison of the leading dimensions of the Fairlies you describe and the Meyers and Fairlies of the Tocopilla Railway is interesting:—

	Burma Railway.	Tocopilla Railway.	
	Fairlie.	Meyer.	Fairlie.
Gauge	3ft. 3¾in.	3ft. 6in.	3ft. 6in.
Minimum curves	300ft.	181ft.	181ft.
Maximum gradients	1 in 25	1 in 25 for 17 miles	
Diameter and stroke of cylinders	14in. × 20in.	14in. × 18in.	14in. × 20in.
Diameter of wheels	3ft. 3in.	2ft. 10½in.	3ft.
Bogie wheel base	7ft. 7in.	6ft. 2½in.	6ft. 10in.
C. to c. of bogies	2 ft. 8½in.	19ft. 4in.	16ft.
Total wheel base	35ft. 7¼in.	25ft. 6½in.	25ft. 10in.
Boiler barrel, largest diameter	3ft. 6½in.	4ft. 4in.	3ft. 5½in.
Boiler barrel, length	8ft. 9in.	11ft 3in.	10ft 8in.
C. of boiler above rails	6ft. 1½in.	6ft. 9¾in.	5ft. 9¾in.
Number of tubes	304	211	234
Diameter of tubes	1¾in.	1¾in.	1¾in.
Heating surface, tubes	1132	1069	1147
Heating surface, water tubes	128	—	—
Heating surface, firebox	138	104	77
Heating surface, total	1398	1174	1224
Area of fire-grate	26	24·1	19·3
Capacity of water tanks, gallons	500	2000	1700
Capacity of coal bunkers, tons	2½	3	2
Total weight in working order, tons	60	53½	57

With a Meyer of 60 tons weight 3000 gallons of water could be carried in the tanks, and ample boiler provided. Of course, the disadvantage would be that the weight available for adhesion would be reduced towards the ends of the journey by the water consumed, but the advantage of being able to dispense with the tender, and to add proportionately to the train load, would more than compensate for this.

So far as I am aware, the Meyers for the Tocopilla Railway are the only engines of this type which have been built in England, but were their advantages realised no more Fairlies would be built, and many mountain railways at present worked with single engines or Fairlies would be much more economically worked by Meyers. The complications in a double engine are more apparent than real, and many of the defects which have been too often repeated can be avoided.

R. STIRLING.

Baku, Russia, June 10th.

BOILERS FOR THE ENGLISH NAVY.

SIR,—In the very interesting article "Boilers for the Navy," published by THE ENGINEER of June 6th, you say the decision taken by the Admiralty for the last cruisers will permit of obtaining a great deal of information concerning the fitness of the Niclausse boiler for use in ships of war, and in regard to another boiler type you add that successful experiments have been gained with it in the Austrian, Swedish and Dutch navies, and that there is hardly room for doubting its fitness.

Will you kindly permit us to give below a complete horse-power list of the boilers we have supplied to foreign navies? You will learn from it that the Niclausse boiler is more used than any other of the lately ordered types. So from the very first it offers every possible guarantee for good working and efficiency, and therefore it is hardly necessary, as you seem to think, to wait for new experiments with it before deciding as to its value.

Navies.	Vessels.	Horse-power.
France	29	210,000
United States	8	148,000
England	8	96,000
Italy	3	47,000
Russia	4	42,000
Japan	3	27,000
Spain	2	23,000
Turkey	2	21,000
Germany	2	17,000
Argentine	1	2000
Chili	1	500
Navies	63	633,500

J. NICLAUSSE.

Paris, June 17th.

CYLINDER LUBRICATION FOR MOTOR CARS.

SIR,—In answer to "Motor Car Man," in your last issue, it is not unlikely that the fault with his lubricator is that the bottom of it is too cold. That is, of course, if he is using a heavy thick oil. Such an oil when cold will not permit water to fall through it. The result of this is that the oil part way down lubricator is practically solid, and on this solid stratum the condensed water rests, so that the oil below this point is not used. There may, of course, be other explanations, but this is the most likely one. "Motor Car Man" can get forced feed lubricators from Hunt and Mitton, Oozles-street, Birmingham, and many others. I would also refer him to a long letter from me to THE ENGINEER in November last.

J. S. V. BICKFORD.

Camborne, June 16th.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Engineers: H. E. J. Reynolds, to the Tamar, for duties at Hongkong Yard, under chief engineer; A. Brown, to the Pembroke, additional, for Chatham Torpedo Store; E. F. Baker, to the Duke of Wellington, for the Kent. Assistant-engineer: E. G. Allen, to the Vivid, for the Edgar. Probationary assistant-engineer: H. E. Hoare, to the Hannibal, for service with inspector of machinery.

MEMORIAL STATUE OF PETER DENNY, LL.D.—The interesting ceremony of unveiling a statue of the late Peter Denny, LL.D., the famous Clyde shipbuilder, took place at Dumbarton on Tuesday week. Occupying a prominent site in front of the new municipal buildings, the statue, which is the work of Mr. W. H. Thornycroft, sculptor, is of commanding appearance. The figure, which is really an excellent likeness of Mr. Denny, is cast in bronze 10ft. in height, and it stands on an Aberdeen granite pedestal 10ft. 6in. high. On its front panel the pedestal has the inscription—"Peter Denny, LL.D., shipbuilder and engineer, born 1821, died 1895. Erected by his friends and fellow-townsmen, 1902." On other two sides of the pedestal there are representations in relief of shipbuilding and engineering, and on the back the arms of the Denny family. A large company, invited by Provost Blair, attended the unveiling ceremony, and at its close were entertained at luncheon. Lord Overtoun handed over the pedestal to the town, paying a warm tribute to the character and work of Mr. Denny, and Bailie Buchanan accepted the gift on behalf of the community. The statue cost over £2000.

AMERICAN ENGINEERING NEWS.

(From our own Correspondent.)

Electric tramway power plant.—The power station of the Cleveland Electric Railway, U.S.A., has a rather novel method of handling its coal. A railway wagon with 30 to 50 tons of coal is carried by a transfer table from a siding to the boiler-house. This table is mounted on twelve wheels, on three pairs of rails, and is operated at a speed of 100ft. per minute by a 25 horse-power motor geared to the driving shaft. At the boiler-house a cable from a small electric winch hauls the car off the table and on to a large lift with steel girders attached to sixteen 1in. wire cables passing over four hoisting drums. The lift is operated at a speed of 10ft. by a 100 horse-power, 500-volt motor. At the upper floor another winch hauls the wagon off, and it is run along an overhead line of rails over the storage bin, into which the coal is discharged by opening the bottom doors or hoppers of the wagon. The empty wagon is then run back to the lift, and lowered either to the ground level or to the basement. In the latter case it is run upon a line of rails under the ashpits, and the ashes are discharged directly into the wagon by shoots, so that there is no handling at all. This plant now consumes 215 tons of coal per day, and delivers 50 cubic yards of ashes per day. There are ten Babcock and Wilcox water-tube boilers, of 400 horse-power, with chain grates, and fourteen Stirling water-tube boilers of 400 horse-power, with Murphy stokers. The coal-storage bin has a capacity of 1500 tons, and from this the coal is fed by gravity through shoots or pipes to the stokers, the supply being regulated by valves. The ashes and cinders drop into receptacles beneath the boiler-house floor, with shoots and valves by which the contents may be delivered into railway wagons in the basement. The generating plant is supplemented by a Williard storage battery of 276 cells, with a nominal rating of 4000 ampère hours.

A tall office building.—One of the latest of the many tall office buildings in New York City is that now under construction on a triangular plot of ground at the intersection of Fifth-avenue and Broadway, from Twenty-second to Twenty-third streets. It will have twenty-one stories, with a total height of about 285ft. from the street. In plan it is a triangle, with a base of 171ft., and a perpendicular of 86ft., all corners being rounded. It fronts on Madison-square, and its isolated position gives it an unusual wind exposure, while the great height and the narrowness at the north end make it necessary to provide ample resistance for wind stresses. The bracing of the steel skeleton frame has therefore been designed to secure great rigidity, and this has been accomplished without interfering with the arrangement of the interior divisions or obstructing the windows. There are thirty-six main columns. In all the outer walls the masonry is carried by wall girders at each floor. For the first twelve stories, and the eighteenth storey, there are plate girders, but all the other stories have wall girders made of pairs of 15in. channels. In all cases there are solid web triangular knee braces or gussets at both ends of every girder, riveted to the columns and to the top and bottom booms of the girders. The knee-brace plates form extensions of the webs of the plate girders, or are riveted between the 15in. channels; they are secured to the columns by angle irons, and are stiffened by pairs of angle irons riveted to the inclined edges. The floor beams are generally plate girders, with knee braces above and below at each column, these braces being formed of pairs of steel channel bars. The floors are of terra-cotta blocks, forming flat arches, with maximum spans of 6ft., and a thickness of 15in. The weight of floor, including beams, girders, and terra-cotta, is about 100 lb. per square foot. The steel skeleton frame requires about 3680 tons of steel work.

Variable speed electric motor.—A recent development in American electrical apparatus is a direct-current motor whose speed may be varied at will over a wide range without the use of controllers or other auxiliary devices, and without appreciable variation in efficiency. The motor is shunt-wound, and is similar to other machines of that type, but the field magnets are hollow, and contain iron plungers which may be moved to or from the armature. This movement has the effect of varying the magnetic circuit, and—correspondingly—the magnetic flux. The field strength around the edges of the pole faces remains practically constant, and the change in flux is concentrated over the central portions of the pole faces. In this way the conditions of commutation remain practically constant, and sparkless commutation is secured through the full range of speed. The frame of the fields support four tubular inward projecting field magnets, with closed pole faces at their inner ends and open at their outer ends. A soft steel plunger is fitted to the bore of each field magnet, and is moved inward or outward by a threaded nut forming the centre of a bevel wheel. The shafts of these bevel wheels are operated from a bevel wheel on a hand-wheel shaft, so that all are operated simultaneously, thus obtaining a complete magnetic balance of the armature at all times. This multi-speed variable reluctance motor is built by the Stow Company, of Binghamton. The 6 horse-power motor is designed for speeds of 700 to 1500 revolutions per minute, and at any speed within these limits the machine develops its full rated power, with an efficiency of only 2 per cent. less at maximum than at minimum speed. This efficiency is 82 per cent. at minimum, and 80 per cent. at maximum speed.

Automatic block signals.—The use of automatic block signals is now quite extensive in the United States, and is spreading rapidly, especially on the large and busy railways, such as the Pennsylvania railroad, the Baltimore and Ohio railroad, the Chicago and North-Western railway, and some forty or fifty others. In fact, about 3500 miles of railway are now automatically signalled, with delays and troubles even less than under the manual systems, and a much less expense for operation and maintenance. Both disc and semaphore signals are used, the latter being now most generally used, and they are operated either by electricity direct, or by compressed air with electrically-controlled valves. One of the most interesting of recent automatic signal installations is that of the Boston elevated electric railway, with its very frequent service of trains, making very short block sections necessary. The Westinghouse electro-pneumatic system has been adopted, with an average pressure of 70 lb. in the air pipe. The electrical current is of small volume and low electromotive force, the former being 0·025 ampère and the latter 10 volts. The signal cylinder is 3in. diameter and 4in. stroke. Each signal is equipped with an attachment for automatically setting the air brakes on a train which should try to run past the signal when at "danger." The movement of a signal from "danger" to "safety" is accomplished in two seconds, and represents about one-seventh of 1 horse-power. There are about 175 signals on this line. They are worked upon the normally "safety" principle, and so frequent are the trains that each signal is operated about 660 times per day. In the electro-pneumatic signals on the four-track line of the Pennsylvania railroad a single cell of storage battery in the base of each four-arm signal post supplies current for operating the valves of all four signals and for the two adjacent track circuits.

A new moulding machine.—The latest development of moulding machines in the United States is in the form of a machine for moulding moulds and cores for curved cast iron pipe, and what are known as special castings for water and gas mains. Any size over 20in. diameter can be made; they are made on end instead of on the side, can be made of any angle and radius, and both mould and core are made on the same machine from the same centre. A pit of sufficient size to receive the largest mould to be made is excavated and lined with masonry. At one end are two head blocks with a horizontal shaft, to which are pivoted two rolled steel joists extending out over the pit and fastened together with bracing. On rails at each side of the pit run two trucks, straddling the pit. The rear truck carries a windlass with chain attached to the free end of the steel joists. The front truck has two uprights with a crosshead sliding upon them. Rods attached to this crosshead are fitted with a disc or former, whose diameter is that of the outside of the casting to be made. The flask is clamped upon the steel joists, which are raised until the disc is at the bottom of the flask. Sand is rammed in between the disc and flask, and the beams are gradually lowered as the ramming proceeds, so that the radius of the casting will be equal to the distance from the centre of the shaft to the centre of the flask. If the end of the casting is to be straight, or tangent to the curve, the lowering of the joists is stopped when the end of the curved portion is reached, and the disc is then raised vertically by the crosshead, while the sand ramming proceeds as before.

Sea protection works at Galveston.—After the terrible storm and flood which devastated the city of Galveston, U.S.A., on the Gulf Coast, in 1900, a board of engineers was appointed to report upon methods of protecting the city from future disasters. The city is on the east end of an island, with elevations of 3¾ft. to 5¾ft. above normal sea level, and a maximum elevation of 9ft. At eight different times from 1834 to 1900 there have been disastrous overflows due to storms in the Gulf. The storm of 1900 was the most serious, its maximum and minimum elevations being 15¾ft. and 10ft. above normal sea level, or 6ft. above the highest previous flood. The plan proposed by the Board of Engineers is to build a solid concrete sea wall over three miles long, the easterly end connecting with the south jetty of the channel connecting the open sea with the strip of water lying between the island and the mainland. This wall would be on the beach, running in a south-westerly direction from the jetty. The city itself should be raised by filling to an elevation of 8ft. to 12ft. above sea level, so as to raise it above the reach of storm waves, and to build on this an embankment—adjacent to the sea wall—rising to a height of 18ft. above sea level at 200ft. from the wall, and thence having a landward slope of 1 in 50. The concrete sea wall is to be 16ft. wide at the base, 5ft. on top, and 16ft. high, with a vertical back and curved face, and reinforced by embedded steel bars. It would have a pile foundation, and the toe would be protected by sheet piling and by a heavy bed of rip-rap extending 27ft. seaward from the wall. The embankment, forming the backing of the wall, would have a promenade level with the top of the wall, a 30ft. roadway, paved with brick, and thence covered with Bermuda grass. The total cost is estimated at £700,000.

Automatic signals on the Pennsylvania Railroad. — The Pennsylvania Railroad, U.S.A., has the first 104 miles of main line from New York equipped with automatic track-circuit block signals, and almost the entire distance has four lines of rails, while at several points there are additional lines for slow goods trains to keep out of the way of through passenger trains. The Westinghouse electro-pneumatic system is used, with semaphore signals. The blocks are less than a mile in length—mostly 2000ft. to 4000ft. —and all stations and yards are equipped with interlocking plants. Points which are not operated from a signal box and interlocked are electrically connected, so as to short-circuit the current of the track battery whenever the points are open for the siding, thus setting the block signals of that section at "stop." On the newest part of the signal equipment steel bracket posts are used, with two short posts on top and two arms to each post. The power is compressed air, and the valves are operated by electricity; the current is supplied by a storage battery enclosed in the base of the post, these being charged from a generator which supplies about 20 miles of line. The storage batteries supply current for the track circuits as well as for the signal instruments. The steel posts are 20ft. 6in. high, surmounted by posts 13ft. high. The air pipe is laid underground between the lines of rail, and the feed wires for the batteries are carried on poles. The power-house has two air compressors, and two 12½ horse-power steam engines, each of the latter directly connected to a Westinghouse generator. These can charge the batteries in ten hours with current sufficient for twenty-four hours' service. At manual interlocking plants the controlled manual system is used; the man can lower the signal when the line is clear, and the train in passing returns the signal to "danger." On the 85 miles between New York and Philadelphia there are eighty-one through passenger trains daily, exclusive of a heavy goods and suburban traffic.

Water purification in the United States.—A recent inquiry into the status of water purification systems in the United States shows that 243 cities and towns are operating the various methods in vogue for improving the quality of public water supplies, while some 68 others have filter systems of more or less efficiency. The plants are summarised as follows:—Mechanical filters, 141; slow sand filters, 21; sedimentation basins, 53; filter galleries, 14; filter cribs, 11; softening plants, 2; aërating plants, 5; total, 247 plants in 243 cities and towns. Most of the settling basins and filter cribs effect only a partial clarification with more or less reduction in bacterial contents. The mechanical filters vary greatly in efficiency. Probably the majority of them were originally designed to remove mud, silt, and other suspended matter. This was particularly true not only of such filters but also of many other kinds of purification works until within the past few years. A good proportion of the mechanical filters installed of late, however, and nearly all the slow sand filters are designed primarily to remove bacteria. A large majority of the mechanical filtration plants are owned by water companies, while a smaller majority of the slow sand filters are owned by the cities. While few of the larger cities are supplied with filtered water, eighteen out of thirty-seven places having a population of over 100,000 are either treating their supplies in whole or in part or are taking steps to do so. At New York and Boston small portions of the water supply which would otherwise be objectionable or dangerous are purified. At Kansas City and Omaha settling basins are employed. Denver has sedimentation, mechanical filtration and filter galleries. Purification works are being built at four large cities and have been decided upon for four others, while still another four are agitating the question very seriously, although nothing definite has yet been decided upon.

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Cours de Construction du Navire. Par L. Callou. In two volumes. Tome Premier et Second. Paris: Augustin Challamel. 1902. Prix 40f.

The Hennebique Ferro-Concrete System. By L. G. Mouchel, M. Inst. C. E. (France). London: L. G. Mouchel, 38, Victoria-street, S.W.

Cours de Topographie. Lever des Plans de Surface et des Plans de Mines. Par Alfred Hobets. Troisième edition. Paris: Ch. Béranger. 1902.

Elementary Coal Mining. By George L. Kerr, M.E., M. Inst. M. E. With 200 illustrations. London: Charles Griffin and Co., Limited. 1902. Price 3s. 6d.

Pipes and Tubes: Their Construction and Jointing. By Philip R. Björling. With 191 illustrations. London: Whittaker and Co. 1902. Price 3s. 6d.

The "Royal" Road Book of Ireland. By Harry R. G. Inglis. With 200 "Contour" plans. Edinburgh and London: Gall and Inglis. 1902. Price 1s. net.

The Valley of Zermatt and the Matterhorn. A guide by Edward Whymper. With illustrations and maps. Sixth edition. London: John Murray. 1902. Price 3s. net.

Chamonix and the Range of Mont Blanc. A guide by Edward Whymper. With illustrations and maps. Seventh edition. London: John Murray. 1902. Price 3s. net.

Duncan's Manual of Tramways, Omnibuses, and Electric Railways of the United Kingdom, and the Foreign and Colonial Companies that are Registered in England, &c. &c. 1902. London: T. J. Whiting and Sons, Limited. Price 5s.

City and Guilds of London Institute. Department of Technology, Exhibition-road, S.W. Programme containing Regulations for the Registration, Conduct, and Inspection of Classes, and Examination of Candidates in Technology and Manual Training. Session 1902-1903. London: Whittaker and Co. Price 9d. net.

THREE-TON ELECTRIC JIB CRANE

STOTHERT AND PITT, LIMITED, BATH, ENGINEERS

THREE-TON ELECTRIC CRANE—CLYDE NAVIGATION TRUST.

WE illustrate herewith the first electric crane which has been built for the Trustees of the Clyde Navigation. Hitherto this body has exclusively used hydraulic cranes, six of this type being installed on the South Quay, Prince's Dock, Glasgow. The new electric crane has been placed to work side by side with and under similar conditions to these hydraulic cranes, in order that the Trustees may be in a position to fairly compare the two systems. The specification of the crane was drawn up by Mr. George H. Baxter, the mechanical engineer to the Clyde Trust; but a free hand was given to firms tendering in respect of design, provided that the general requirements were complied with. The leading particulars are as follows:—Maximum working load, 3 tons; total lift, 80ft.; radius 41ft.; centre of jib pulley above quay, 60ft.; extreme radius of tail, 9ft. The specified speeds were:—Lifting speed for 3-tons loads at 150ft. per minute; slewing speed at load, 300ft. per minute. We are informed that these speeds were considerably exceeded at the test of the crane. The truck and undercarriage is constructed on similar lines to those of the existing hydraulic cranes. The crane runs on rails, the gauge of which is 14ft. from centre to centre. The wheel base is also 14ft. The crane is provided with hand travelling gear. The arch between the legs is of sufficient height to allow of the passage underneath it of locomotives and wagons.

The roller path is of cast steel, and carries a ring of cast steel live rollers, 24 in number, the live ring being centred by radius rods. The upper roller path is also of cast steel, and carries the superstructure of the crane, which is bolted down to it. The revolving superstructure consists of a framework of steel girders, connected by cast iron cross stretchers, through the middle of one of which passes the centre pin, which anchors the revolving portion down to the truck. The general construction of the remainder of the crane framework may be gathered from the illustration.

In its equipment this crane displays several novelties. Among these is the lifting gear which represents the outcome of the many years' experience which the makers have had in this class of work, and their latest practice as covered by the various patents taken out or controlled by them. The main feature of the gear is that the winding drum is detachable, thereby, as the makers claim, ensuring a large gain of speed in working together with an economy of current. The load is lifted on the single part of a steel wire rope—made by T. and W. Smith, of Newcastle—this rope being coiled on a spiral groove in the lifting barrel without overlapping. The lifting barrel runs loosely on its shaft, and is connected and disconnected by means of a friction clutch. The clutch which Stothert and Pitt prefer as having in their experience proved most efficient, and as having stood the test of some years of constant use in a satisfactory manner, is the Lindsay coil clutch. The barrel shaft carries the main spur wheel rigidly keyed on to it, and this spur wheel gears directly, by single reduction, with the pinion attached to the armature spindle of the lifting motor. The gearing runs in an oil bath.

A friction brake is keyed directly to the lifting barrel. The friction clutch is worked by a hand lever which is also directly connected to the lifting controller. On moving the lifting handle forward from the "off" position the barrel clutch is put into gear and the motor started simultaneously. When the clutch is in gear, further movement of the handle cuts out resistance and speeds up the motor. In addition to this mechanical arrangement there is an electric solenoid which acts on the friction clutch. The mechanical connection of friction clutch and controller lever, with the device for enabling the motions of the handle to be continued after the clutch is "home," is worked under a patent of Mr. Aldridge, the electrical adviser to the Southampton Harbour Board. The brake is mechanical, but is interlocked, under another patent with the controller, so that when the brake is holding the barrel the motor cannot be started. There is no electrical brake. With this system lifting can be continued at full speed, and the load brought to rest instantly by pulling over a handle, the load being arrested suddenly while the armature goes on revolving. The gain of time in lowering, which, it is claimed, can be carried out at a speed much in excess of that obtainable with a reversible motor, is said to be the distinguishing feature of this type of crane. Lowering can be commenced instantly without perceptible pause from lifting at full speed. The lifting armature can continue to revolve with slackening speed during the period of lowering, and comes to rest without shock.

We are informed that when working at Glasgow this crane was loading bundles of wire rope—weighing about 2½ tons—from railway trucks into a large vessel, picking them up and slewing them round through a semicircle, and it performed twenty-one cycles in fifteen minutes. We are further informed that when working side by side with a hydraulic crane of the same capacity, loading trucks with iron ore, the electric crane easily held its own. The slewing motion is worked by a separate motor and a controller, the motor acting on a train of cut gearing. There is a friction brake, by which the swinging can be arrested quickly if required.

The electric equipment, which has all been supplied by Siemens Brothers and Co., consists of one series-wound lifting motor, designed to give 50 brake horse-power at 280 revolutions per minute, and one series-wound slewing motor, designed to give 10 brake horse-power at 820 revolutions per minute, together with the necessary controllers, instruments, resistances, &c. The motors are of the Siemens' 4 E type, completely enclosed, and designed to work on a 230-volt circuit, the armatures being of the slotted drum type with former wound coils. Current is taken up from terminal plug boxes fixed on the quay. The plug is contained in a cast iron hood, which fits the sockets in the terminal box and makes a joint, through which it is said that it is impossible for water or dirt to penetrate.

SCOTTISH ASSOCIATION OF MUNICIPAL ENGINEERS AND SURVEYORS.

THE first general meeting of the Scottish Association of Municipal Engineers and Surveyors was held in the City Chambers, Edinburgh, on Saturday, the 14th inst. There was a large attendance, and Mr. William Dyack, Aberdeen, one of the vice-presidents of the Association, was called to the chair.

The Chairman said that it was very gratifying to learn that the endeavours to promote an association of the kind had been attended with so much success. He had no doubt it would be the means of promoting a more extended knowledge of municipal work among the individual members, and it would also result in a distinct advantage to the various towns and boroughs throughout Scotland and to the municipal rulers thereof.

Bailie Telfer said that in the absence of the Lord Provost it was left to Bailie Waterston and himself to tender to the members of the Association a cordial welcome to the city. An association such as that would not only be of immense importance by way of the mutual improvement and support it gave, but it must prove of immense value to the corporations of Scotland.

Mr. A. B. M'Donald, M. Inst. C.E., city engineer, Glasgow, thereafter delivered his presidential address. He began by thanking the members of the Association for their kindness in conferring on him the honour of being their first president. The necessity, he said, that impelled the constitution of an Association of Municipal Engineers and Surveyors, to whose meetings they could all repair, had been long recognised by members of the Institution of Civil Engineers and of the Association of Municipal and County Engineers as a matter involving neither disloyalty nor conflict, and it was hoped that the movement which that day assumed definite form might so augment itself that its permanence would be effectually secured. Everyone entrusted with the expenditure of public money must be animated by strong anxiety that the outlay was made to the greatest advantage, and this feeling was of necessity accentuated year by year as the duties of a municipal engineer were continually widened, and a more varied extent of technical resource was needed in their fulfilment. Within recent years such a change had taken place in the aspirations of local government as obliterated the easy-going conditions that prevailed thirty years ago. Practice regulated by rule of thumb had been replaced by methods of precision, and the opportunities that occurred for the leisurely contemplation of ordinary projects had disappeared in the more enlightened recognition of the ever-increasing progress of sanitary science and the improved conditions that pervaded every department of municipal endeavour. This advance, of course, entailed a corresponding enlargement in the professional equipment of all municipal officers, and every engineer must be conscious of the urgent necessity of enlarging his knowledge of civic work, and keeping himself in touch with the most recent developments of public activity, if he hoped to maintain his place in the arena. To do this it was imperative that he should possess the opportunity of frequent personal examinations of public works in course of execution. He trusted no one would for a moment suppose that he underestimated the value of a thorough scientific training as a preliminary necessity. On the contrary, it had always appeared to him that no engineer could possibly over-educate himself in applied mathematics and cognate branches of exact knowledge. But it must not be forgotten that the utmost extent of his acquirements in this direction only put him in possession of tools which he had yet to learn to use, and that it was in the observation of the practice made use of by experienced engineers that he alone could derive secondary practical instruction. The information they all desired could be obtained only in the interchange of ideas and the frank communication of such special knowledge as they themselves had derived in the course of practice, such information as experience had placed beyond the range of speculation or empiricism, and was yet in complete harmony with theoretical science. For each of them, he trusted, still regarded himself as a student, and all of them must be conscious that in the growth of municipal enterprise there was much to learn, that the work of learning must be taken up while it was yet day, and that in fulfilment of the aim of their new Association they should unite in the earnest endeavour that this dissemination of practical instruction should be as wide and as free as they were able to make it.

Bailie Waterston then moved a vote of thanks to Mr. M'Donald for his address, and the Corporation of Edinburgh having been thanked for placing the City Chambers at the disposal of the Association, the meeting terminated with a vote of thanks to the Chairman.

After an inspection of the museum in the City Chambers, the members journeyed to Portobello by a special cable-car, placed at their disposal by the Tramway Company, and a visit was paid to the cable power station and the baths.

CATALOGUES.

CHRISTENSEN ENGINEERING COMPANY, Milwaukee, U.S.A.—Catalogue No. 51 of motor-driven air compressors, stationary and portable.

ARTHUR LOWCOCK, Limited, Shrewsbury. New fuel economiser catalogue issued.—The book is very tastefully produced, and gives all particulars of this device.

EMPIRE ROLLER BEARINGS COMPANY, Limited, Westminster.—A pamphlet entitled "Comparisons of Roller Bearings," by Thomas W. How, F.R.G.S.

HUBERT GRENFELL, Limited, Parliament-mansions, Victoria-street, London, S.W.—Booklet containing a description of the Grenfell system of recording communications in ships of war, being "the necessary complement to the Grenfell gear."

FERRANTI LIMITED, Hollinwood, Manchester. — Catalogue of continuous current meters approved by the Board of Trade. The contents include a clear illustrated description of this meter, the forerunner of its type. The general appearance of the book is highly pleasing.

THE BIRTH OF AMERICAN MANUFACTURES.

THE following extract from the *Morning Herald* of August 24th, 1815, is full of interest. The varied spelling of Pittsburg is curious, The Evan mentioned is obviously Oliver Evan, one of the pioneers of steam navigation.

AMERICAN MANUFACTURES.

The following account of the manufactories established at Petersburg is extracted from a Philadelphia paper:—

(1) A steam rolling and slitting mill, connected with which is a machine for cutting and heading nails, which is done with great facility, of 70 horse-power, on Evan plan.

(2) A steam flour mill, of 24 horse-power, on Evan plan, driving three pair of stones, which grinds about 60,000 bushels annually.

(3) A steam paper mill, of three vats and 34 horse-power on Evan plan, in which the consumption of rags is about 120,000 lb. yearly.

(4) A steam cotton factory, of 24 horse-power, on Watt and Bolton's plan.

(5) A steam woollen factory and fulling mill, of — horse-power, on a new plan by the owner, Mr. Arthurs.

(6) A wire manufactory propelled by steam.

Steam engines.—There are three extensive establishments in this place for the making of steam engines.

(1) The Pittzburg Steam Engine Company construct them on Evan's plan. This establishment is very extensive, embracing a foundry and a smithery; the hands employed by this company are about 100 generally. Many of the anchors were made by this company for Commodore Perry's squadron on Lake Erie.

(2) Bolton and Watt's plan improved are made extensively by Thomas Copeland.

(3) The Mississippi Steamboat Company, on Fulton's plan.

Steamboats.—In 1810 the building of steamboats was commenced here by Mr. Roosevelt, of New York, by building the New Orleans, of 138ft. keel, and between 300 and 400 tons burthen, after which were built the Vesuvius, Enterprise, Etna, and Buffalo, besides which, the ——, lately launched, and one on the stocks, which will be launched in the ensuing summer.

Glass.—There are at this place two white and three green glass-houses. This article of manufacture has become one of the staples of our trade. The amount of glass manufactured annually is valued at 200,000 dols. Glass cutting is also connected with this establishment, and it is done not inferior to the best cut glass in Europe.

Air foundries—There are in Pittzburg three large and extensive air foundries, where are cast all kinds of alloy ware, castings, common balls, smiths' anvils and irons, steam engine, sugar boilers, iron boilers for distilleries, &c.; besides one in Birmingham—a new town opposite Pittzburg—where all kinds of small work is done, and a small foundry for casting butt-hinges, buckles, &c.

A mill for boring cannon is connected with one of the above foundries.

Breweries.—There are three breweries on an extensive scale. They consume about 30,000 bushels of barley, and manufacture 10,000 barrels of porter, beer, and ale annually. Worth about 60,000 dols.

Lead.—Two white, and one white and red white-lead manufactories, to which are connected chemical laboratories.

Woollen.—There is a large woollen factory, which makes all kinds of cloth, blankets, vest patterns, hosiery, felting, &c., besides several smaller ones.

Cotton.—There is, beside the one propelled by steam, several smaller cotton factories, which together make an immense quantity of various kinds of goods.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—Necessarily, the holidays and celebrations in connection with the Coronation are causing a good deal of disorganisation, and mean practically a stoppage of both business and industrial operations from Wednesday until Tuesday next. Buying is, perhaps, not quite so active as a week or two back, directly following the proclamation of peace, but there is a good deal of inquiry on the market, and the situation all through shows a steady and very substantial improvement. All round, prices continue to harden, and if this persistent stiffening of the market can go on in what is usually the dull season of the year, and notwithstanding ordinary operations for some weeks past have been thrown out of their regular gear, there would seem to be a prospect of still higher prices when business settles down again into its ordinary course.

Amongst iron trade representatives the question is naturally being asked, in view of the present smallness of stocks and the fact that production is all being disposed of, what is likely to be the course of the market towards the autumn, when there is usually a considerable influx of buying. Any materially lessened cost of production, in the matter of either wages or fuel, is scarcely now anticipated, and both merchants and makers who look into the future, are very cautious about committing themselves to forward engagements.

On the iron market here the attitude of makers and manufacturers is in most cases one of exceeding firmness, and a good deal of business has been declined recently rather than meet the cutting prices at which some transactions have been put through. In pig iron moderate transactions have been effected, and a considerable business is offering, but at prices which makers do not care to entertain. Lancashire makers are very firm at 58s. 6d., less 2½ for No. 3 foundry, delivered Manchester. The position of Lincolnshire is somewhat anomalous. With one exception makers have practically nothing to offer on the market, but the basis price remains 53s., with iron offered through merchants at under even this figure. It is rumoured that one or two merchants are pretty large holders of Lincolnshire iron bought at below current rates, and they are, of course, in a position to compete for business. This, it is understood, has for the time being checked an official advance, which, from the makers' standpoint, would seem to be justified, but in most cases they are readily getting 53s. 6d. net, delivered Manchester, or 6d. above the basis price. Derbyshire foundry brands remain scarce, and quotations strong at from 56s. 6d. to 58s. net, delivered Manchester. On forge qualities there is a stiffening in prices, notwithstanding the unsatisfactory position of the finished iron trade. For Lincolnshire 53s. 2d. net has been got without difficulty, delivered Warrington, and a similar basis on sales made in other districts, with forge Lancashire averaging about 54s. to 54s. 6d., less 2½, delivered Warrington. Middlesbrough and Scotch iron go on steadily hardening, and during the last week or two have established an advance of 6d. to 1s. per ton. No. 3 foundry Middlesbrough, by rail Manchester, is scarcely quoted for ordinary consumers' parcels under 58s. 4d. to 58s. 10d. net, but special sales might be made at a trifle less; Eglinton, delivered Manchester docks, is not now quoted under 57s. 9d. to 58s., with Glengarnock 61s. 6d. to 62s. net.

The finished iron trade remains much as last reported. The present very restricted foreign business is being seriously felt by the large producers here, the home demand, although fairly good, being altogether inadequate to take off their output. Some of the smaller forges are kept fairly going; but taking the position all through, the rolling mills are only indifferently off for work. Prices are without quotable change. Lancashire bars remain £6 10s., with North Staffordshire £6 10s. to £6 15s.; sheets are strong at £8 2s. to £8 7s. 6d., and hoops steady on the list basis of £7 2s. 6d. random to £7 7s. 6d. special cut lengths delivered here, and 2s. 6d. less for shipment.

Raw material in the steel trade is not sharing in the improvement that is generally reported in pretty nearly all descriptions of manufactured steel. Hematites are not more than maintaining late rates, 68s. to 68s. 6d. net being average quotations for ordinary No. 3 foundry, with special brands about 69s. delivered here, and local made billets, which are beginning to feel German competition, remain £4 18s. 9d. Warrington, and £5 Manchester, net. Steel manufacturers are all getting very full of work, and are stiffening in their quotations; £6 10s. to £6 12s. 6d. may still be given as almost the average prices for steel bars, but in some cases manufacturers are quoting £6 15s.; common steel plates £6 5s. to £6 7s. 6d.; and makers of boiler plates have no difficulty in booking all the orders they care to entertain at £7 10s., less 2½ delivered here.

In the engineering trade the stoppages of works for the Coronation are in some cases extending over the whole week, one or two large firms taking advantage of the present holidays for stock-taking purposes, and closing their works from Saturday until Monday next. Generally the stoppage extends from Wednesday night to Monday, but it is not expected that shops will get into really full work again until Tuesday. With regard to the trade position very little change is noticeable. Some of the engineering firms engaged on heavy work both for home and abroad are exceedingly busy. In structural engineering there is also a good deal doing both in connection with bridge and roof work. Boilermakers also continue well engaged. Locomotive builders have orders to keep them going well into next year, and pressing activity is maintained in the electrical and allied branches of engineering. Machine tool makers are in some directions booking an increased number of orders, but generally they are but moderately off. Except in one or two special branches, the textile machine trades remain without real improvement.

The Council of the Amalgamated Society of Engineers has addressed a circular letter to the district committees, asking for expressions of opinion respecting the one-break system, which has recently come to the front in the Manchester and other districts. The matter has already been discussed with the employers, and it is stated that the Council obtained from the Federation a pledge that there should be no extension of the system pending further discussion at an executive conference. In the meantime the pledge given has been loyally observed.

Another question which has recently given rise to some difference between the employers and the workmen is the introduction of the "premium bonus" system at some of the Manchester works, and we understand that a local conference on the matter is pending. The workmen claim that this is an altered condition of labour, introduced without consultation with them, to which they take exception, on the ground that no reference was made to such system when the 1898 settlement terms were arrived at.

Mr. John Hodge, of Manchester, secretary of the British Steel Smelters' Association, is to be nominated as a candidate for the secretaryship of the Parliamentary Committee of the Trade Union Congress, in opposition to Mr. S. Woods, the present occupant of the office.

In anticipation of the stoppage of the pits throughout Lancashire for the Coronation celebrations, extending from Wednesday this week, and in most cases practically until Tuesday next, before they are likely to get again into full work, there has been some extra inquiry to secure such supplies as may in the meantime be requisite, and this has tended to compensate for any falling off in the demand for house-fire consumption as a result of the more summerlike weather of the last few days. Collieries have been moving away all their output, and will, in most cases, re-start after the holidays, practically bare of stocks. This is a situation which will necessitate pits being kept on full time through the summer to enable collieries to get down the stocks they usually require to meet the winter's extra requirements. There is consequently no probability, so far as Lancashire collieries are concerned, of any large surplus of coal coming on the market to weaken prices, and the general anticipation is that these will undergo no further material downward move during the remainder of the year.

For house-fire descriptions there was a good inquiry up to the stoppage of the pits, which has taken away all that collieries have been raising, and prices remain firm on the full list basis. Common round coals are also in moderately good request for steam and forge purposes, but as there is at most works a cessation of operations for several days, no extra inquiry of any amount has come forward for this class of fuel to cover requirements during the pit stoppages. Prices are being steadily maintained at about 8s. 6d. to 9s., with some special sorts fetching 9s. 6d. at the pit.

For engine fuel the increasing inquiry reported of late is being more than maintained, and collieries are anticipating quite a pressure upon the medium and better qualities of slack, which is not unlikely to lead to some hardening in prices. As previously intimated, there are large requirements for electric power stations in various parts of the district, and for all good descriptions of slack prices are exceedingly strong at from 6s. 6d. to 7s. at the pit mouth. Where collieries have at all any material supplies of engine fuel it is almost entirely in the inferior sorts, which continue to be kept down in price by the competition of common slack coming in from other districts, chiefly Derbyshire and Staffordshire. This competition is, perhaps, not quite so pressing as a short time back, but prices continue low, common Lancashire slack ranging from about 4s. 9d. to 5s. 6d. per ton at the pit.

The shipping trade remains moderate, with prices about as last quoted, ranging from 9s. 9d. to 10s. for medium, up to 10s. 3d. better qualities of steam coal, delivered ports on Mersey.

For coke there is a continued active inquiry at full rates, averaging 22s. to 24s., best Lancashire foundry; and 13s. 6d. to 14s. 6d. furnace cokes; and 13s. 6d. to 14s. good washed Yorkshire furnace cokes, to 14s. 6d. some special sorts at the ovens, and makers disinclined to contract forward except at somewhat advanced prices.

The Lancashire and Cheshire Miners' Federation, at a meeting held in Manchester on Saturday, had before them the question of the reduction in wages, and on the advice of their leaders, of course accepted Lord James' decision. At the same meeting arrangements were made for a conference to be held shortly at Southport on the eight hours question.

Barrow.—There is a steady trade doing in hematite pig iron, and although the warrant market is weaker, makers feel strong in the fact that they are already well supplied with orders, that business is offering on a comparatively large scale, and that the prospects of trade are still very good, there being every indication of a strong and full trade before the autumn sets in. Makers quote the old price of 60s. 6d. net, f.o.b., for mixed Bessemer numbers, while warrant iron is at 59s. 10½d. net cash sellers, buyers 3d. less. Stocks of warrant iron have not been reduced during the past fortnight; they are steady at 13,907 tons, the lowest point touched by stocks since warrant stores were opened in the district. There are 36 furnaces in blast, compared with 35 in the corresponding week of last year.

Iron ore is a steady trade, and good average sorts are at 12s. per ton net at mines, with best sorts at 16s. per ton. The importation of Spanish ores into the district is still well maintained, and there is practically as much foreign as native ores used by the smelting furnaces of the district. Good Spanish ores are quoted steadily at 15s. per ton net at West Coast ports.

There is a deal of life in the steel trade, and orders are not only largely entered on makers' books, but they are being largely offered alike for prompt and forward delivery. It is evident from present indications that a large business will be done at an early date with colonial and general foreign buyers of steel, but Germany is a keen competitor for orders, and consequently prices are kept at a low point. Rails are in full demand, chiefly for heavy sections. Light rails are only a small trade. A fairly good business is being done in tram sections. Ship and boiler plates are in better request. The boiler-plate trade during recent years has not been so active as previously, owing to the displacement to a large extent of the cylindrical for the water-tube boiler, but under new conditions battleships and cruisers will be fitted with both types of boilers. General steel produce is in good demand.

Shipbuilders and marine engineers are exceedingly busy, and are likely to remain so.

An agreement has at length been come to between the Corporation of Barrow and the British Electric Traction Company, Limited, to lease the Barrow tramways to the latter for twenty-one years. Electric traction will be used, and the work of transforming the tramroad from steam traction to electric is to be accomplished in six months.

Coal and coke quiet. Shipping fairly employed.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THE work of the week does not take much telling. It has been, practically, a holiday week. In anticipation of the Coronation festivities, the colliers have been working very well, bringing a heavy weight to bank. The demand is quite equal to the supply, as the output was considerably lessened through the miners' demonstration at Rotherham. Perhaps the most satisfactory feature in the Yorkshire coal trade is the spirit in which the men have accepted the decision of Lord James of Hereford in regard to the coalowners' application for a reduction of 10 per cent. in wages. The amount represented by the reduction—some £15,000 or £16,000 in Yorkshire—is not quite so large as the general public anticipated, but the miners freely express the opinion that the present action of the employers is only the beginning of a policy which may have far-reaching issues. Meanwhile, however, the award is being loyally observed. In other directions of the Yorkshire coalfield there is some trouble, and thus the outlook is not so pleasant as could be desired.

House coal, in the better qualities, continues brisk, but there is no animation in the secondary qualities. In Barnsley house there is a fairly steady market, with an absence of business on speculative account. Quotations range from 12s. per ton in best qualities to 10s. per ton seconds and nuts.

Steam coal is in a satisfactory condition, with an excellent trade in nearly all directions. Coalowners have no difficulty whatever in finding a market for the whole of their output, prices remaining at the rates current at the beginning of the year, when the majority of the railway companies contracted at 9s. per ton, though one railway company got in at 3d. per ton less. Railway managers are now seeking to renew contracts on that basis, which wou'd mean that contracts for the latter half of 1902 would rule at 8s. 9d. per ton. Arrangements with that object are now in progress.

In the general industries of the city there is no alteration to report. The distress at the East End, owing to the continued absence of armour and other military material orders, is being generously met by private generosity, and relief is being actively administered. As the orders are now certain within a few days, and may probably be placed before these lines see the light, the various firms are taking on more men for the preparatory processes of manufacture, but, of course, it will be a considerable time before there is employment for those concerned in the finishing departments.

In the iron market further advances have taken place, Lincolnshire irons having generally gone up 6d. per ton. It is evident that dealers are now buying largely for stock. In iron circles the animation is attributed to the termination of the war, with every prospect of activity in the South African markets. Another cause is the renewed demand on American account. This call from the States has chiefly affected Middlesbrough irons, which have, for the present, ceased to compete with those from Lincolnshire. There is a better business doing in the finished iron trade as well. No improvement as yet is perceptible in the general run of the steel industries.

King Lewanika visited Sheffield on Saturday and was entertained to luncheon by the Lord Mayor, witnessed the rolling of an armour plate, and several of the processes of gunmaking, and in the lighter industries the silver-plating and cutlery crafts. The establishments visited were Vickers, Sons and Maxim; Walker and Hall, Electro Works, Howard-street; and Joseph Rodgers and Sons, Limited, Norfolk-street. The King, who was conveyed from Vickers, Sons and Maxim's works to the Town Hall in a motor car, was presented with silver-plate cutlery, another example of Sheffield production. The King appeared to be greatly gratified with his visit and reception.

NORTH OF ENGLAND.

(From our own Correspondent.)

THOUGH business in the iron and allied industries of this district is naturally very quiet this week, still the actual condition of trade is not worse than last week, nor are prices weaker; on the contrary, in Cleveland pig iron they are stronger, notwithstanding the poor shipments and the persistent increase this month in the stocks in the public warrant stores. Yet, while a little while ago lower prices were accepted for forward than for prompt delivery, that is not the case at present, and higher prices have to be paid where the delivery is forward than will be taken where the execution of the order is to be early. That may be considered as indicating a sanguine view of the future. This, however, can only be reported of ordinary Cleveland pig iron, for as regards hematite there is not the least change for the better, nor any likelihood of any while there is depression in the shipbuilding industry. Makers of hematite pig iron in this district are much more affected by this depression than are the pig iron makers of other districts, because in the North-east of England steel and pig iron makers depend so so much upon the shipbuilders for keeping them going. It would seem inevitable that the production of hematite iron in this district should be reduced, more especially as in addition to the slackness of demand, the cost of manufacture with most firms exceeds the selling prices, and tends to become higher still, as both ore and coke are becoming dearer. Too much hematite is offering here, and the makers have to keep their price for mixed numbers at 57s. per ton, whereas their competitors on the West Coast can get 60s. All efforts to advance the prices of hematite here are apparently of no avail, and competition is keen. The unsatisfactory character of this branch of the iron trade is shown by the fact that the price of mixed numbers has this year improved but 2s. 6d. per ton, whereas ordinary Cleveland pig iron has gone up nearly 7s. per ton.

The situation with respect to ordinary Cleveland pig iron is better than it has been for some time, more especially where the lower qualities are concerned. They have risen till they are relatively as dear as No. 3, though for a long time they have been less; but now they have become very scarce indeed. No. 4 foundry has been during the last few days almost unobtainable. It is years since the available supply of this quality was so short of the requirements, and the difficulty has not been for sellers to find buyers, it has rather been for buyers to meet with any one in a position to sell.

The demand from the Continent is less than it has been during

any spring of the last decade, and in a great measure this is due to the fact that our prices are too high compared with those at which German iron can be bought; but the difference is not so great as it was, for the Germans are gradually getting over the effects of their over-trading, and are not so much disposed to sell at unprofitable prices. No. 3 Cleveland pig iron is now at 49s. 6d. per ton, which is a fair figure compared with what is ruling for East Coast hematite iron. No. 4 foundry has been raised to 49s., and is not readily forthcoming at that. Grey forge is at 48s. 3d., mottled at 47s. 9d., and white at 47s. 3d.

There is not much that is new transpiring in the finished iron and steel industries, and except in the rail trade there is no activity in demand, nor are manufacturers very sanguine about the early future, though they look for some improvement in the autumn, as an outcome of the late war. As yet, its termination has not had any influence on business here, but it is too soon to expect it, though in the Midlands a change has been brought about. The slackness in the trade is indicated by the length of the holidays for the Coronation; some of the works are closed for the whole week, more particularly shipyards and engineering works, and they will lose nothing by prolonging the holidays, because orders are not plentiful enough to keep them going. The railmakers will have shorter holidays than any of the manufactured iron and steel works, and there are good prospects of the present briskness being maintained. Not less than £5 10s. per ton net at works will be accepted for heavy steel rails. Steel ship plates are at £5 15s.; steel ship angles, £5 12s. 6d.; iron ship plates and angles, £6 2s. 6d., all less 2½ per cent. The syndicate of bar makers, which comprises the firms not only in the North of England but also in Scotland, has the price fixed at £6 5s., less 2½ per cent. f.o.t. for common iron bars, and other qualities in proportion. Makers of plates and angles do not expect that by reducing their prices they would do any more business, and they prefer not to bring their quotations below cost of production.

A notable departure is to be taken by the governors of the High School at Middlesbrough with a view of affording facilities for the spread of technical education. They hold that after an apprentice or other workmen at the engineering works, shipyards, iron and steel works, &c., has done his day's work he is not in a fit state to take full advantage of the evening technical classes even if he is disposed to attend. The proposal of the governors now is to establish day technical classes for such apprentices, &c., and they appeal to the employers to allow these apprentices to attend such classes on one afternoon in the week, and to count this in as part of their regular work.

At the annual meeting of Head, Wrightson and Co., Limited, Teesdale Iron and Engineering Works, Thornaby-on-Tees, the chairman, Mr. C. Arthur Head, said that their foundries, instead of being fully occupied during the year, were for four months working for only about one-half of their total output, and as other ironfoundries were in a similar position, the competition for orders was keen, resulting in lower prices and reduced profits.

The coal trade is showing improvement, and up till Wednesday of this week work has been going on at extra pressure to make up for the holidays, which, in the Tyneside district, would have taken place—Coronation or no Coronation. Operations are to be suspended for the latter half of the week. The price of best steam coals has been put up to 11s. 6d. per ton, but seconds have not become stiffer, as they have lately been in better supply than demand; they can be got as low as 9s. per ton, but 10s. was the general figure. Good gas coals are at 9s. to 9s. 6d. Foundry coke varies from 17s. to 17s. 6d. per ton, f.o.b., while medium quality furnace coke, delivered on Teesside, could readily be got at 15s. per ton.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE arrangements for the Coronation celebration have interfered a good deal with business, and there is quite a holiday feeling abroad all over the manufacturing districts. The markets are also feeling the effects of the excitement, not in a larger business, but in the general indisposition of dealers to enter into transactions.

The Glasgow pig iron market was arranged to be closed on Thursday and Friday, so that business was only taking place during three days this week. Comparatively little has been done. There is, however, a very good feeling in the market. The general tendency is firmer. Prices of both raw and manufactured iron are tending slightly upwards, and the impression is that better business is likely to be experienced in the near future. There has been little doing in Scotch warrants, which are quoted from 54s. 4d. to 54s. 6d. per ton. A few transactions have been reported within the last few days in Cumberland hematite about 60s. per ton. Cleveland warrants have sold from 49s. 10d. to 49s. 8d. for cash.

A moderate business has been done in Scotch hematite at from 61s. 6d. to 62s. per ton for delivery at the West of Scotland steel works. Since last report one furnace has been taken off hematite at the Glengarnock Steel Works. The total number now blowing in Scotland is 85, compared with 80 at this time last year, and of these 44 are making hematite, 37 ordinary, and 4 basic iron.

The prices of Scotch makers' iron are very steady, and business proceeds at the following rates:—G.M.B., f.a.s. at Glasgow, No. 1, 56s.; No. 3, 53s. 6d.; Wishaw, No. 1, 56s. 3d.; No. 3, 53s. 6d.; Carnbroe, No. 1, 57s. 6d.; No. 3, 54s.; Clyde, No. 1, 66s.; No. 3, 56s.; Gartsherrie, No. 1, 66s. 6d.; No. 3, 57s.; Calder, No. 1, 66s. 6d.; Nos. 3, 56s. 6d.; Summerlee and Coltness, Nos. 1, 70s.; Nos. 3, 58s.; Langloan, No. 1, 70s.; No. 3, 59s.; Glengarnock, at Ardrossan, No. 1, 66s. 6d.; No. 3, 56s. 6d.; Eglinton, at Ardrossan or Troon, No. 1, 57s.; No. 3, 53s. 6d.; Dalmellington at Ayr, No. 1, 56s.; No. 3, 54s.; Shotts at Leith, No. 1, 69s.; No. 3, 58s.; Carron at Grangemouth, No. 1, 68s.; No. 3, 58s.

The shipments of pig iron from Scottish ports in the past week amounted to 7925 tons, compared with 4207 in the corresponding week of last year. The total shipments since the 1st of January are 148,752, being 16,625 more than in the corresponding period of last year. The arrivals of Middlesbrough pigs at Grangemouth were 7561 tons, being 1110 less than in the corresponding week, but these imports show an increase for the year to date of 44,510 tons.

The makers of sheets in the West of Scotland have raised their prices 2s. 6d. per ton on ordinary sheets, and 5s. on nail strips.

Business in the coal trade has not been quite so good for shipment in some parts of the western districts; but there has, on the whole, been a fair trade, taking into account the time of the year. The demand for home consumption is well maintained. There is not much variation in prices.

Accountants are engaged examining the books of the Scottish coalmasters, with the view of making a return to the Conciliation Board on the selling prices of coal during the last two months. The returns thus to be made will be used to show whether the masters are entitled to the reduction of wages which they have recently claimed, or to some modification thereof.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

COAL continues in good demand at all ports, and prices have been maintained for all varieties after the holidays, which threaten to seriously affect most of the pits from Thursday to the end of the week. It is evident, as I write, that it will be a broken week, characterised by a certain amount of vigour and pressure for supplies for half the week, and sluggishness afterwards.

On 'Change, Monday, Cardiff, best steam coals were quoted at 16s. to 16s. 3d., and other varieties were rated as follows:—Seconds, 15s. 3d. to 15s. 6d.; dry, 14s. to 14s. 6d.; best small, 7s. 9d.; seconds, 7s. 3d. to 7s. 6d.; dry and commoner kinds, 6s. 6d. to 7s.; best Monmouthshire, firm, 13s. 3d. to 13s. 6d.; seconds, 11s. 6d. to 12s. 6d.; best semi-bituminous, small, 7s. to 7s. 3d.; seconds, 6s. to 6s. 3d.; best house coal, 15s. to 15s. 6d.; seconds, 11s. 6d. to 14s.; No. 3 Rhondda, 14s.; brush, 12s. to 12s. 6d.; small, 9s. 6d. to 10s.; No. 2 Rhondda, 11s. to 11s. 6d.; through, 9s. to 9s. 6d.; small, 6s. 6d. to 6s. 9d. Patent fuel, 15s. to 15s. 6d., including tax. Coke: Furnace, 16s. 6d. to 17s. 6d.; foundry, 18s. to 21s.; special foundry, 23s. to 23s. 6d. Pitwood weaker, 18s. 6d. to 18s. 9d. Imports have been large, so depression is not expected to be other than temporary, especially for best wood. The latest report from the anthracite districts given on 'Change, Swansea, is as follows:—Stems well filled. Anthracite, best malting, 21s.; seconds, 18s. to 19s.; big vein, 16s. 6d. to 17s.; red vein, 12s. 3d.; machine-made cobbles, 22s.; ditto nuts, 24s.; ditto rough peas and fine peas, 11s. 6d. to 12s.; rubbly culm, 5s. to 5s. 6d.; duff, 3s. to 3s. 6d. Steam coal, 15s. 6d.; seconds, 12s. 6d.; bunkers, 9s. 6d. to 10s.; small, 7s. House coal, No. 3 Rhondda, 14s. to 14s. 6d.; No. 2 Rhondda, 12s. 6d. Patent fuel, 13s. 3d. to 13s. 6d.; furnace coke, 17s. 6d. to 18s. 6d.; foundry, 20s. to 21s. Pitwood, 18s. to 19s. At Llanelly the demand for anthracite continues large. The manager of a large colliery in the Gwendraeth Valley informed a contemporary last week that demand exceeds supply, but that in the next twelve months the output would be double. Prices are now as good as they were two years ago, though steam had declined 5s. So far the American strike had not affected Wales. At Cardiff it was said this week that 4000 tons bituminous coal are on the way to New York from Cardiff to sell at 22s. The Elevated Railway Company has cabled to secure Welsh anthracite.

The sale of the machinery, &c., at the Breconshire works of the Merthyr Urban Council took place last week, and it may be of general interest to place on record some of the prices realised. About 400 tons steel rails brought an average of £3 8s. A locomotive by J. H. Wilson and Co., of Liverpool, produced £380; a 3-ton crane £165, a smaller one of 30 cwt., £50; a bungalow, £105; a mission room, £47; police station and surgery, £30; 60ft. cast iron stand pipe 3ft. 6in. diameter, with inlet valve, bracket, and rods, and two 24in. sluice valves.

It is stated that the Barry Dock Railway Company intends an important extension of its dock accommodation, and will shortly issue tenders.

There is a shipwrights' dispute on at Newport in respect of tariff and rules of work. The employers afforded a few days ago an interesting evidence of self-reliance in dry docking and shoring a vessel by their own manual labour. This I find has not been the only instance of late, and should have a wholesome effect on the struggle.

The healthy character of the iron and steel trades of South Wales was shown by the result of the audit of ironmasters' books at the Abergavenny meeting on Saturday. This justified the declaration of an advance of 1½ per cent.

This declaration indicates a firm market, and the maintenance of prices, the tendency of which is upwards.

Iron, steel, and tin-plate prices were not issued this week from the Exchange, Swansea, in time for my despatch. Iron ore continues firm. Cardiff and Newport prices are:—Rubio, 14s. 3d. to 14s. 1d.; Tafna, 15s. to 15s. 3d.; Almeria, 14s. 3d. to 14s. 6d. c.i.f. At Liverpool on Saturday it was stated that the pig iron market was firmer. Scotch, 54s. 7d. to 55s.; Cleveland, 49s. 11d.; Cumberland, 60s. 1d. Tin lower, £127 to £128. Lead easier, £11 7s. 6d. Copper easier, £54 5s. Spelter steady, at £18 5s. Tin-plates quieter, not much doing. Steel cokes: Wales, 13s. 7½d.; oil sizes quieter, 14s. Wales; ternes, 25s. 6d. Wales; ordinary charcoal, 15s. 6d. Wales.

Several important meetings have taken place between the tin-plate manufacturers and the representatives of the men, and at the last the following ultimatum was presented on the part of employers: "That the principle of following the machinery be accepted, and should difficulties arise between employers and employed, the matter to be brought before the Conciliation Board for settlement. The works management shall, as far as possible, regulate the orders so as to facilitate the working in the mills." No final settlement has been brought about up to date, but, if effected, this will decide the wage rate for twelve months.

The plea of the men is that it has always been the custom to pay the higher rate, namely, fifty sheets to the box, and they do not see why the privilege should be taken away. They claim that doubles are a special class of plates, and the difference existing between employers would be corrected by a uniform arrangement of fifty sheets on doubles. Seeing that the employers had agreed upon Canadas, the men add, why not accept the offer of the men on doubles, which is on the same basis.

The Taff Vale Railway opened last week a new bridge connecting their line with Cilfynydd Colliery and suburbs. It is a substantial structure, designed by their local engineer, Mr. Sibberring, and by Mr. Frazer, of Derby. It has three spans of 90ft. over the railway, and one of 70ft. over the Glamorganshire Canal.

Freights quiet, with no perceptible change in rates. Port Said, 5s. 3d.; Lisbon, 4s. 6d.; London, 3s. 10½d.; Cronstadt, 4s. 9d.; Gibraltar, 5s. 6d.; all Cardiff. Swansea to Genoa is being done at 6s. 3d.

In iron circles it is stated that although the iron and steel works of Cyfarthfa and Dowlais are now the property of Guest, Keen and Co., and under the general management of Mr. William Evans, both works are carried on upon distinct lines. Crawshay Brothers retain the estate, which comprises a number of freehold farms, in their hands, and also the old residence, Cyfarthfa Castle.

The residence of Anthony Bacon, who preceded the Crawshays at Cyfarthfa, is now used as the engineers' office, and as an indication that the old ironmaster was more of a wag than given to heraldic lore, his crest, a boar, is shown on an old fireplace casting, evidently turned out at the works prior to 1800.

The oldest works are those at Dowlais, the next Cyfarthfa, and followed by Penydarran and Plymouth.

NOTES FROM GERMANY.

(From our own Correspondent.)

THE reports received from the various iron and steel producing districts over here state the business transacted upon the week to have been steady, and there was a more lively request coming forward in some branches. Inland consumption in rails, plates, and sheets is active in Silesia, and exports have been heavier than before. Quotations all round are firm, and not likely to alter for the present, at least not in a downward direction, as the occupation at the various establishments is regular and the order books fairly well filled. The employment of the ironworks in Rheinland-Westphalia is irregular, some having been compelled to reduce their working staff, while others have increased the number of their men. Krupp, for instance, is said to have given notice to about 500 men that had been employed in the arms department, but they are likely to find occupation in other branches of the Krupp establishments.

There was a good inquiry experienced for girders lately owing to a fair activity in the building line, while sleepers and rails were somewhat neglected. Sheets realised only M. 135 p.t., bars in basic, M. 119 and M. 121 p.t. at a recent sale in Dortmund; these prices are generally considered pretty satisfactory, being about the same as the present list rates. Much life is stirring in the wire trade. In May of present year the orders booked amounted on 9600 t., against 9100 t. in April, 1902. A Westphalian firm is said to have got an English order for 9000 t. plates at M. 99·50 p.t. free Mülheim-Ruhr; the price, however, is so low that it seems doubtful whether this can be true. Large foreign orders for locomotives are reported to have been placed with several German shops quite recently; there is talk of a hundred locomotives, and the value is estimated to amount on six million marks. The contracts, which are for India, Siam, Italy, and Denmark, have to be executed till spring, 1903.

Last week the iron market in Austria-Hungary has been pretty firm, and ironmasters have slightly advanced the prices for raw iron, bars, and girders. The business in structural iron is more lively than in previous weeks, and the machine department has also been somewhat better employed than formerly. Demand is moderate, and activity in the various departments of the French iron industry has been rather limited upon the week; prices, however, have shown much steadiness.

On the Belgian iron market the business recently done was principally on foreign account, but the orders received, though numerous, and of considerable weight in many instances, leave little profit, because the prices for coal are too high and in no proportion to those of iron and steel. A reduction in the prices for coal would very likely cause an improvement in the iron business. The order for 188 locomotives, worth about 15 million francs, which the Belgian State Railways have given out a short time ago, will secure employment for some time to the shops, that have been up to the present very moderately occupied.

An unsatisfactory condition continues to prevail on the coal markets in France and in Belgium. German coa'owners likewise complain of an irregular trade, and of the weakness in quotations, which has even increased for some sorts.

Import to Hamburg is officially stated to have been worth 2160·7 million marks last year; export was worth 1819·5 million marks; import shows a decrease of 120 million marks, while export was 8·5 million marks higher than in 1900.

AUSTRALIAN NOTES.

(From our own Correspondent.)

A VERY important Commission has been arranged for the purpose of dealing with the question of the conservation and distribution of the waters of the river Murray and its tributaries, for the purposes of irrigation, navigation, and water supply, and to report on the just allotment of the waters of the Murray basin to the use of each of the States of New South Wales, Victoria, and South Australia, and for the best methods for their conservation and distribution. The commissioners appointed to investigate into this matter are Mr. J. Davis, M. Inst. C.E., Under-Secretary for Public Works, New South Wales, who is to be president; Mr. S. Murray, M. Inst. C.E., Chief Engineer for Water Supply, Victoria; and Mr. F. Newman Burchell, engineer and surveyor in the department of the Engineer-in-Chief, South Australia.

Another of the many disasters of broken tail shafts has been added to the list, this time to the well-known steamer Boveric. The steamer left Melbourne for Durban on March 21st, with 965 horses, a crew of 98, and 6 passengers. On April 3rd, when about 1000 miles west of Fremantle, the tail shaft broke outside, and the propeller was lost. An endeavour was made to keep in the track of steamers, but as the boat was drifting northwards, the lifeboat was rigged and manned by the chief officer, second officer, and two able seamen, with instructions to make for the nearest land and report the casualty. This was when the boat was about 1500 miles from Fremantle, to which port they made in twenty-seven days. Two steamers were then fitted out for the search of the steamer, but in the meantime the Lund liner Narrung, which left Albany (W.A.) on May 3rd for South Africa and London, sighted the Boveric on May 9th, and took her in tow back to Fremantle, arriving there on May 15th. Only fifty-two horses were lost during the trying time, and no further mishap occurred.

There is still no signs of the drought breaking, which is proving so disastrous in New South Wales and Queensland. Word has been given to-day—May 17th—that the water supply for the city of Sydney and suburbs will fall below gravitation point by next week, when pumping will have to be resorted to. This is the first time on record that such an event will be necessary, and fears are entertained of the stability of the embankment of the reservoir by the lowering of the water to such an unusual depth. A special plant has been erected for the purpose of pumping.

The drought in Queensland has had the effect of stopping the running of Cobb and Co.'s coaches. These well-known contractors had the running of the coaches carrying the mails in the interior of that State, where railway communication is not provided. About forty-three services are affected, covering about 4000 miles of road. All postal communication and passenger traffic in the interior has been stopped, and in many cases food supplies. It is stated by their manager that the feed account this year would be nearly £30,000, whereas in normal years it would be about £6000.

In consequence of the strategical and postal point of view, it is deemed expedient, by the Commonwealth Government, to take immediate action for the appointment of a commission of the leading railway engineers to expedite the inquiry as to the practicability of making railway communication between West and South Australia. This would then give railway connection with all the capital cities in Australia.

THE ROYAL AGRICULTURAL SOCIETY.—The show will be held this year at Carlisle, July 5th to the 11th. There are no trials of implements.

NAVAL CADETSHIPS.—The Civil Service Commissioners state that a revised scheme of examination for the entry of naval cadets will come into operation in March, 1904, and that copies of the syllabus may be obtained on application to the secretary of the Civil Service Commission, Burlington-gardens.

THE MACHINERY USERS' ASSOCIATION.—The annual general meeting of the Machinery Users' Association was held on Thursday, the 19th inst., at the Westminster Palace Hotel. Sir W. H. Houldsworth, Bart., presided, and amongst those present were:—Mr. W. H. Holland, Mr. George White, Mr. W. E. M. Tomlinson, Mr. Lewis Evans, treasurer, Major Vane Stow, and others. Sir William Houldsworth, in moving the adoption of the report and accounts, referred to the improved position in which the Association stood, owing to the Report of the Royal Commission on Local Taxation and of the recent judgment of the Lord Chief Justice in the case of Crockett and Jones and the Northampton Union Assessment Committee. A recent decision in Scotland, adverse to the manufacturers, had brought a great amount of Scotch support to the Association. Mr. Lewis Evans referred to the question of water supplies as being a most important one for manufacturers. Mr. W. H. Holland spoke with approval of the formation of the Commercial Committee in Parliament.

THE ROLLING STOCK COMBINE.—We understand that the Birmingham Railway Carriage and Wagon Company, Limited, instead of actually joining the recently formed railway rolling stock combine, has arranged a pooling or division of orders with the Metropolitan Amalgamated Railway Carriage and Wagon Company, Limited, and that some similar arrangement is contemplated between the Metropolitan Amalgamated Company and the Bristol and Gloucester companies. The Birmingham and Metropolitan companies have already, it is reported, cut up between them one big order for rolling stock for South Africa. Unless we are greatly mistaken, the proposed line of action will be stoutly resented by railway companies and other buyers, and already we hear of coming orders for India and Argentina which will be studiously withheld from the rolling stock companies in the "pool" and given to makers quite outside their influence. In fact, it is the intention of one important Indian group to foster, in every possible way, the spirit of healthy competition in the rolling stock trade, and its orders will in future be given to some of the smaller wagon and carriage builders.—*Herapath's Railway Journal.*

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, June 11th.

PRICES received within twenty-four hours from all the leading steel centres in the United States indicate rather a critical condition of things owing to the enormous purchases that have recently been made. The greatest urgency is for Bessemer and basic pig. Both eastern and western consumers are in the market, and are endeavouring to close negotiations for delivery during the winter and next spring. Though phosphorus pig is quoted to-day as high as 23 dols., large sales having been made within a few days at 22·50 dols., large lots of southern basic pig have been purchased delivered in Western Pennsylvania at 19·25 dols. Bessemer has advanced, and another advance is pending at present writing. Production has been resumed in the Bessemer pig iron district, but the maximum capacity will barely cover the minimum requirements. Four or five furnaces have blown out within a few days in Western and Middle Pennsylvania, and others will be obliged to follow suit next Saturday. There will be no suspension of blast furnace production in the Pittsburg or Ohio districts. The terms of the workmen have been conceded. There is less concern to-day over steel billets owing to assurances from abroad that large supplies can be had at fair prices. Negotiations are closing to-day for large blocks, the exact amount of which the importing interests decline to state. Great activity prevails this week in plate and structural material in this market, and at Pittsburg and Chicago. The buyers have recently appeared with urgent requirements, the effect of which will be to mark up prices for what are regarded as early deliveries. Throughout the West foundries, pipe works, implement, and machine shops are all in the market for supplies, crude and finished. The effect of this rather unexpected demand has been to put up prices for autumn delivery. Southern pig iron has advanced 1·00 dol. per ton, as against two weeks ago. No. 2 foundry is now quoted at 17 dols. delivered in western markets. Cast iron pipe has gone up 1·50 dol. per ton, and large negotiations are now pending before another advance is forced. Merchant pipe is very active, and mills are choked up with orders. Rail makers are unable to accept some of the orders offered within the past few days. Speculative demand exists for rails, and especially for light sections. Very few structural iron mills in the country are in a position to accept orders of any magnitude for delivery this year. Prices now range from 2 dols. to 4 dols. per ton over association rates.

Black sheets and galvanised are in extraordinary demand and prices are held at card rates. The first arrival of 6000 tons of foreign rails has reached Pensacola, and the remaining 24,000 tons will arrive shortly. More dependence is now being placed on foreign sources of supply of rails, billets, and certain other materials. The strained condition of things in Alabama has led to the projected construction of two additional furnaces of large capacity. Several railroad companies have made inquiries for steel rails for winter delivery, but at present writing no definite results have been reached with reference to the orders under consideration. The output of coke in the Connellsville coke region has reached 250,000 tons per week and the demand is heavy. Contracts have been placed at 2·50 dols. per ton for coke to be delivered during the balance of the year. Seventy-two-hour foundry coke is quoted as high as 3·00 dols. The scarcity of fuel at a good many furnaces has interfered with deliveries. Cars are scarce. Large speculative transactions in copper have occurred within two or three days, which has had the effect of temporary advancement in prices. Consuming interests in a general way are well covered and are not participants in this movement. The fluctuations in the market are chiefly due to the pressure of small consumers for immediate deliveries. Exports for the week were comparatively light, amounting to 2019 tons. The pig tin market has been very quiet. American buyers have temporarily withdrawn. Only a moderate amount of business has been done in pig lead. Prices are still based on 4·12½ cents for 50-ton lots. The market is still practically bare of spelter, and it is quoted nominally 4·87½. The prospect of a continuance of the anthracite strike is having a rather depressing effect upon trade in general. There is a general unrest among the bituminous coalfields of the west, and it is this uncertainty that is causing a good deal of apprehension.

LAUNCHES AND TRIAL TRIPS.

SANDON, steam tug; built by, John Cran and Co., Leith; to the order of, Alexandra Towing Company, Limited, Liverpool; dimensions, 92ft., 20ft., by 12ft.; engines, compound surface condensing, 16in., 42in., by 24in., pressure 150 lb.; speed of 11 knots was maintained over long courses; trial trip, June 13th.

TAMAR, steel screw steamer; built by, Craig, Taylor and Co., Stockton-on-Tees; to the order of, the Royal Mail Steam Packet Company; dimensions, 342ft., 46ft., by 27ft. 6in.; engines, triple-expansion, 25in., 42in., 68in., by 45in., pressure 180 lb.; a speed of 11·6 knots was maintained; trial trip, June 17th.

TRADE AND BUSINESS ANNOUNCEMENTS.

MR. ALFRED BALDWIN, of Kensington Palace-mansions, De Vere-gardens, W., has joined the Board of the Central Insurance Company, Limited.

TENDER of the Hart Accumulator Company, Limited, for storage battery for Sculcoates Union, Beverley-road, Hull, has been accepted by the Board of Guardians.

EASTON AND CO., Limited, have appointed Messrs. Reunert and Lenz, of Johannesburg and elsewhere, sole agents for the whole of South Africa for the sale of the Schmidt patent superheaters, and also for the sale throughout the same territory, except Cape Colony, of their electric and hydraulic lifts. They have also engaged Mr. Francis G. Cowlrick, of 37, West Dulwich-mansions, S.E., as their representative for the South of England.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

☞ When inventions have been "communicated" the name and address of the communicating party are printed in italics.

10th June, 1902.

13,173. PLAITING MACHINES, H. H. Lake.—*(G. J. Burns, United States.)*
13,174. TABLE GAME, P. M. Justice.—*(A. E. Orr, India.)*
13,175. POLYPHASE CURRENT SYSTEMS, Siemens Bros. and Co., Limited.—*(Siemens and Halske Aktien-Gesellschaft, Germany.)*
13,176. PLAYING MUSICAL INSTRUMENTS, H. H. Lake.—*(The Æolian Company, United States.)*
13,177. PORTABLE OZONISING INHALER, E. Coustau, London.
13,178. STEAM CHAFF CUTTING MACHINE, J. W. Robinson, London.
13,179. COOKING RANGE CONSTRUCTION, T. Rogers, London.
13,180. CHANGING CARD, R. Kloss, Liverpool.
13,181. CURRENT COLLECTORS of ELECTRIC TRAMCARS, J. Wetter.—*(P. Pfeiffer, Germany.)*
13,182. TABLE TENNIS NETS, L. R. Harrington and E. Stone, London.
13,183. PLAYING MUSICAL INSTRUMENTS, H. H. Lake.—*(The Æolian Company, United States.)*
13,184. GAMING APPARATUS, E. R. Marshall, London.
13,185. RECIPROCATING PUMPS, F. C. Haste and C. W. Milne, London.
13,186. PUMPS, J. Ravier, London.
13,187. STREET SWEEPERS, P. R. Hansbury, London.
13,188. COMBINED SKIRT SUPPORTER, J. Gorham.—*(W. Scatchard, jun., United States.)*
13,189. PORTABLE DARK CHAMBERS for PHOTOGRAPHIC PURPOSES, J. Lambert, Liverpool.
13,190. TOBACCO PIPE, E. T. and Y. S. Towgood, and J. Allison, Liverpool.
13,191. BORING APPARATUS, W. P. Thompson.—*(Mecklenburgische Gewerkschaft "Friedrich Franz," Germany.)*
13,192. PLAN SIFTERS, J. Weyermann, Liverpool.
13,193. PORTABLE VAPOUR BATHS, A. W. Southey, London.
13,194. SUPPORTING MOTOR CAR BODIES, E. S. Doré, London.
13,195. APPARATUS for MARKING FABRICS, D. Anderson, London.
13,196. COIN-FREED APPARATUS, J. M. Alderton and W. Heinen, London.
13,197. OIL MOTORS, E. Valentin, London.
13,198. BOTTLE-WASHING MACHINES, J. Kayser, London.
13,199. CASTING APPARATUS, H. H. Franklin, London.
13,200. PRINTING PRESSES, J. Y. Johnston, London.
13,201. PRINTING PRESSES, J. Y. Johnston, London.
13,202. EXPANSIVE FLUID MOTOR, A. J. Boult.—*(F. W. Zimmer, ———.)*
13,203. MAIL BAGS, J. H. and P. J. Hutton, and E. E. Crook, London.
13,204. CIGAR CASES, S. Stern, London.
13,205. ELECTRIC CLOCKS, J. Bühler, London.
13,206. FRICTION CLUTCHES, A. Bolzani, London.
13,207. ELECTRIC TELEPHOTOGRAPHIC APPARATUS, A. J. Boult.—*(L. Semat, Egypt.)*
13,208. GAS BURNERS, J. Harris and L. H. Vogel, London.
13,209. VARIABLE DRIVING GEAR, R. J. White and T. S. James, London.
13,210. GAS ENGINES, R. J. White, T. S. James, and W. H. Slinn, London.
13,211. PROCESS for DECORATING GLASS, J. De Pew Kyle, London.
13,212. BED PANS, G. S. Heatley, London.
13,213. SHEARING TOOLS, J. K. Stewart, London.
13,214. REFRIGERATING APPARATUS, W. H. Walker, London.
13,215. VALVE MECHANISM, R. Haddan.—*(T. H. Haberkorn, United States.)*
13,216. TREATMENT of PHOTOGRAPHIC PICTURES, A. Englefield, London.
13,217. MERCERISING MACHINES, J. Spengle, London.
13,218. COUPLING APPARATUS for RAILWAY VEHICLES, T. A. Brockelbank, London.
13,219. FLOWER POT, E. J. Stichler, London.

11th June, 1902.

13,220. FASTENINGS for LADIES' SKIRTS, R. de Witt, London.
13,221. KNITTED FABRICS, A. E. Adams, W. A. Sheffield, and J. Hallam, Leicester.
13,222. INCANDESCENT GAS BURNERS, P. Brandenburg, London.
13,223. LOOMS, E. Smith, Bradford.
13,224. "LIGHT in a WIND VESTA," F. M. Bower, Bradford.
13,225. TOY, A. E. Hawley, Kingston-on-Thames.
13,226. PIPE JOINTS, W. S. Corbin, Kingston-on-Thames.
13,227. STEAM PUMPS, J. Andrews, Cathcart, Renfrewshire.
13,228. AUTOMATIC WEIGHING MACHINE, R. B. Sangster, Rogart, Sutherland.
13,229. THREADING NEEDLES, J. Ward and R. Bibby, Preston.
13,230. FOOTBALL BLADDERS, J Neilson, Cathcart, Renfrewshire.
13,231. CISTERN FITTINGS, W. Ede, J. and W. J. Woolven, Portslade, Sussex.
13,232. MEASURING APPARATUS, W. P. Smith, West Oldham.
13,233. VARIABLE SPEED COUNTERSHAFTS, E. H. Liebert Manchester.
13,234. BARBED WIRE for FENCING, J. Millar, Dundee.
13,235. BRICKS, S. H. Adams, London.
13,236. MACHINES for FOLDING COLLARS, G. Crawford, Halifax.
13,237. WORKING BRAKES of TRAMCARS, W. Dixon, Glasgow.
13,238. SAWING BARS of IRON, W. and A. R. Copley, Halifax.
13,239. DRIVING GEAR for CYCLES, R. McClean, Glasgow.
13,240. SHIFTING POINTS of TRAMWAYS, G. D. Ross, Glasgow.
13,241. SCARF ORNAMENTS, G. H. Johnstone, Birmingham.
13,242. SPRING ATTACHMENT for CARDS, J. and S. V. B. Smith, Birmingham.
13,243. BEDSTEADS, F. Evers, London.
13,244. FURNACE DOORS, W. Partington, Nottingham.
13,245. WATER SPRAYING APPLIANCE, W. H. B. Stevens and J. Rhodes, Derby.
13,246. AN AUTOMATIC REGULATOR, H. A. Purnell, Glasgow.
13,247. SECURING LADIES' HATS, T. Campbell, Glasgow.
13,248. ROTARY AIR COMPRESSORS, W. E. Cook, Glasgow.
13,249. DISTRIBUTING ARTIFICIAL MANURE, J. Marshall, Glasgow.
13,250. VENTING DEVICE for CASKS, H. Dent, Leeds.
13,251. TROUSER PRESSER, F. H. Whitehouse, Sheffield.
13,252. WHEELS and PULLEYS, J. R. Pickering, Leeds.
13,253. BINDING for BOOKS, S. F. Oakland, Burton-upon-Trent.
13,254. PARTITIONS, E. N. Shute and W. Burgess, London.
13,255. ELECTRIC MEASURING INSTRUMENT, A. C. Heap, London.
13,256. NETS for PING-PONG, &c., J. M. Mackintosh, London.
13,257. CONSTRUCTING BUILDING BLOCKS, E. Bauman, London.
13,258. LIFEBUOY, L. Boelling, London.
13,259. SKIRT PROTECTOR, W. Sachs and R. Horstmann, London.
13,260. CONSTRUCTION of CEILINGS, P. Runkel, London.
13,261. TRIPOD HEAD for CAMERAS, T. Walton, Sunderland.
13,262. FRAMES of VELOCIPEDES, J. Wootton, London.
13,263. AUTOMATIC BRAKE APPARATUS, A. J. M. Jones, London.
13,264. CHECK ACTION for PIANOS, B. Robertson, London.
13,265. DEVICE for HAIR CLIPPERS, W. Mackie, London.
13,266. COMBINED MARINE TORCH, W. J. Underwood, London.
13,267. FUSIBLE ELECTRIC CUT-OUTS, W. P. Burke, London.
13,268. ARTIFICIAL HORIZONS, J. M. Stratton, London.
13,269. CLEANSING PAPER, The Knopf Patent Paper Pulp Syndicate, Limited.—*(Anna Barbara Knopf, née Fuckshuber, Germany.)*
13,270. CUTTING POCKETS in SASH FRAMES, J. Terry, London.
13,271. LIQUID CONTROLLING APPARATUS, C. F. Mendham, London.
13,272. SELF-CLOSING VALVES, W. A. G. Schönheyder, London.
13,273. GAS and EXPLOSION ENGINES, M. Taylor, London.
13,274. GULLEY GRIDS, E. Parry and F. W. Bidder, London.
13,275. SAFETY DEVICE, E. Parry and F. W. Bidder, London.
13,276. ANIMAL FEEDING DEVICE, J. B. Cole, Birmingham.
13,277. BUCKETS, C. H. Hill, Birmingham.
13,278. CYLINDERS of MOTOR ENGINES, G. Pilkington, Birmingham.
13,279. PERAMBULATORS and MAIL CARTS, I. N. Dann, London.
13,280. PNEUMATIC TIRES for WHEELS, G. E. Heyl-Dia, Liverpool.
13,281. TRAM SEATS, W. C. Bruce and R. H. Fleetwood, Liverpool.
13,282. BELT FASTENER, H. H. Lake.—*(Gordon Clasp Company, United States.)*
13,283. EAR PENDANTS, A. A. Geiger, D. C. Bauer, and J. Pejchar, London.
13,284. TIRES for the WHEELS of VEHICLES, M. Weiss, London.
13,285. WARPING FRAMES or REELS, L. Moncorgé, London.
13,286. COUPLING SHAFTS, E. H. E. Bouhey and R. P. A. le Grand, London.
13,287. TRANSMISSION of SOUND for SUBMARINE PURPOSES, H. H. Lake.—*(Submarine Signal Company, United States.)*
13,288. TRANSMISSION of SOUND for SUBMARINE PURPOSES, H. H. Lake.—*(Submarine Signal Company, United States.)*
13,289. MOULDS, A. A. Geiger, D. C. Bauer, and J. Pejchar, London.
13,290. VENTILATING BUILDINGS, W. Pritchard-Morgan, London.
13,291. TIME-INDICATING APPARATUS, L. Kusnick, London.
13,292. MOTOR CARS, J. F. Mason, London.
13,293. FLUID-PRESSURE ENGINES, T. Smyth-Thorpe and S. N. Wellington, Colombo, Ceylon.
13,294. APPLYING a WATERPROOF COATING to VARIOUS ARTICLES, H. H. Lake.—*(The Société Anonyme le Carbone, France.)*

12th June, 1902.

13,295. CYCLING SKIRT, M. J. Fisk, Southsea.
13,296. HOT WATER CIRCULATION, F., W., E., and H. Claughton and E. Austin, Leeds.
13,297. ELECTRIC TROLLEY HEAD, J. J. Carter, Clonskeagh, Co. Dublin.
13,298. CANDLESTICKS, M. Cates, Bristol.
13,299. CASE to HOLD a MENTHOL CONE, A. W. Shirley, London.
13,300. MACHINERY for SAWING STONE, G. Anderson, Dundee.
13,301. MELTING ORES, G. Hales and A. E. Paulson, Hull.
13,302. BRAKES for CYCLES, W. and J. Clarke, Wolverhampton.
13,303. MOULDING SOLES, J. Gimson and Gimson and Co., Limited, Leicester.
13,304. CHAIRS, H. Lipson, Liverpool.
13,305. HOLDERS for WASHING UTENSILS, B. Draper, Liverpool.
13,306. SMOKE CONSUMER for FURNACES, H. Haughton, Halifax.
13,307. CLEANING of FLOWER POTS, J. T. Grice, Birmingham.
13,308. LIFEGUARDS for TRAMCARS, D. Newton, Liverpool.
13,309. SEAT ATTACHMENT for CHAIRS, A. H. Hunting, Kingston-on-Thames.
13,310. CAMELEOSCOPE, S. M. Sargant, Handborough, near Woodstock, Oxon.
13,311. PROCESS of SCOURING FABRICS, R. H. Lendrum, Keighley.
13,312. RIM BRAKES for VELOCIPEDES, G. Taylor, Coventry.
13,313. ADVERTISING or DISPLAY CARDS, H. V. Baker, London.
13,314. WINDOW-SASHES, J. Walker, Glasgow.
13,315. GOLF BALL, St. Mungo Manufacturing Company, and A. C. Wood, Glasgow.
13,316. DOOR SILLS, J. J. McMenemy, Glasgow.
13,317. WATER TAPS, J. Finlayson, Busby, Lanarkshire.
13,318. STEAM ENGINES, H. S. Clay, London.
13,319. METALLIC PACKING, W. H. Owen, Glasgow.
13,320. BEE-HIVE, A. Reid, Rosshire, N.B.
13,321. A SHADOW PENDANT, F. W. Heim, Baden, Germany.
13,322. PEDAL DRIVING APPARATUS, W. S. Steljes and The Typewriting Telegraph Corporation, Limited, London.
13,323. ARRESTING the PASSAGE of LIQUID, G. E. Lloyd, London.
13,324. NOVELTY, F. Archer, Nottingham.
13,325. BRICK-MOULDING MACHINES, T. Parker, Roydon, Essex.
13,326. MEANS of MEASURING GARMENTS, H. W. Hilder, London.
13,327. FURNACES, W. R. Wills, Sheffield.
13,328. FURNACE, A. Paget.—*(N. W. Emmens, United States.)*
13,329. TRUSSES, W. Walker, London.
13,330. DRESS PRESERVERS, C. Rehn, London.
13,331. SASH LOCKS, H. H. Goucher, London.
13,332. STUDS, N. Hollanders, London.
13,333. CLOCKS, W. Kilsby, London.
13,334. GAS-WASHING SURFACES, H. Kirkham and S. A. Chandler, St. Leonards-on-Sea.
13,335. CAMERAS for PHOTOGRAPHIC PURPOSES, E. J. Castle, London.
13,336. TROUSER PRESSER, G. Schadler, London.
13,337. ORDNANCE, A. Reichwald.—*(T. Krupp, Germany.)*
13,338. MANUFACTURE of OIL COLOURS, J. F. Raffaëlli, London.
13,339. GAS GENERATOR, F. B. Felt and M. Greene, London.
13,340. LADDERS, J. Becker, London.
13,341. TYPE-JUSTIFYING MACHINES, W. H. Lock.—*(The Thorne Type-setting Machine Company, United States.)*
13,342. TYPE-JUSTIFYING MACHINES, W. H. Lock.—*(The Thorne Type-setting Machine Company, United States.)*
13,343. CEILINGS, J. Hughes, London.
13,344. LIQUID AERATING APPARATUS, H. H. Lake.—*(J. H. Champ, United States.)*
13,345. FOWL-INCUBATING APPARATUS, C. H. Payne, London.
13,346. ANEROID BAROMETERS, J. J. Hicks, London.
13,347. FLUSHING APPARATUS for DRAINS, H. Bonsor, London.
13,348. DETONATING EXPLOSIVES, F. M. Hale and G. W. Bell, London.
13,349. CART with MOVABLE PLATFORM, R. Liebscher, London.
13,350. DOOR FASTENINGS, R. le Jeune, London.
13,351. PHOTOGRAPHY, O. Fulton and W. M. Gillard, London.
13,352. HYDRAULIC MIXERS, C. K. Graham, Lee, Kent.
13,353. TREATING STARCH, W. P. Thompson.—*(A. P. Anderson, ———.)*
13,354. TICKET HOLDERS, A. and L. Myers, Birmingham.
13,355. LEAF-TURNING APPARATUS, J. G. Inshaw and F. Billing, London.
13,356. TREATMENT of GARBAGE, R. B. Newport, London.
13,357. ELECTRIC TRAMWAY TROLLEYS, The British Thomson-Houston Company, Limited, and F. Samuelson, London.
13,358. LAMP, L. Hirigoyen, London.
13,359. NON-REFILLABLE BOTTLES, L. D. Parks, A. D. Honeycut, H. S. Compton, and W. M. Watson, London.
13,360. CHAIR SPIDERS, H. W. Bolens, London.
13,361. DETACHABLE HEELS for BOOTS, M. L. Hansen, London.
13,362. SHIPS' SIDELIGHTS, F. G. P. Preston, J. Gillies, and W. R. Hayes, London.
13,363. ORNAMENTAL STOVE SCREENS, S. Pinner, London.
13,364. STENCIL PRINTING APPARATUS, S. Brown, London.
13,365. RADIATOR TUBES, La Société Anonyme des Automobiles Peugeot, London.
13,366. PRODUCING SCINTILLATING EFFECTS for TOYS, W. Walters, London.
13,367. COIN-FREED GAS METERS, T. Glover, London.
13,368. APPARATUS for BOTTLING LIQUIDS, F. G. Hampson, H. Swales, and The Automatic Aërator Patents, Limited, London.
13,369. CENTRIFUGAL FANS and PUMPS, S. C. Davidson, London.
13,370. THREAD GUIDES for SPINNING MACHINES, G. C. Marks.—*(L. T. Houghton, United States.)*
13,371. TRAMCAR OBSTRUCTION REMOVER, J. Paterson, London.
13,372. SECTIONAL BOOKCASES, F. L. Forster, J. A. and M. Conrey, and A. H. Hildreth, London.

13th June, 1902.

13,373. FOOTPATH GUTTERS, J. H. Butler, jun., Wolverhampton.
13,374. AIR-RADIATING APPARATUS, T. Etherington and E. Atkinson, Blackburn.
13,375. OBTAINING VANADIUM from ORES, S. Cowper-Coles and Co., Limited, and S. Cowper-Coles, London.
13,376. APPLYING VANADIUM in IRONMAKING, S. Cowper-Coles and Co., Limited, and S. Cowper-Coles, London.
13,377. HEAT-MEASURING APPARATUS, H. L. Callendar, London.
13,378. TIPS for BOOTS, J. J. Eckert, Strood, Kent.
13,379. COVERS for RUBBER TIRES, M. Lipowsky, London.
13,380. UNIVERSAL FEED SEWING MACHINES, W. Bowden, Manchester.
13,381. SIMULTANEOUSLY LOCKING DOORS, A. F. Grant, Glasgow.
13,382. GAS BURNERS, T. Senior and G. T. Challinger, Huddersfield.
13,383. CLEANING TOOTHED SURFACES, H. N. and A. B. Rhodes, Huddersfield.
13,384. GAS METERS, J. H. Hamilton, Derby.
13,385. MACHINES for SPLICING LEATHER, S. Haley, Halifax.
13,386. FILTERING, S. H. Adams, London.
13,387. INTERNAL COMBUSTION ENGINES, J. Gartside, Manchester.
13,388. CIGARETTES, J. E. Wenke, Manchester.
13,389. LOCKS for RAILWAY CARRIAGE DOORS, W. K. Kaye, Bradford.
13,390. BICYCLE SUPPORTING BRACKETS, W. H. Forsyth, Bristol.
13,391. CONDENSER TUBE STOPPER, J. McIntosh.—*(G. McIntosh, High Seas.)*
13,392. PLEATING FLOUNCES on FABRICS, The Singer Manufacturing Company, S. Mort, and A. Liston, Glasgow.
13,393. GAS COOKING STOVES, C. E. R. Terry and G. H. Walker, London.
13,394. IRON BRICK MACHINE DIE, J. Milward and H. Waterman, Maidstone.
13,395. BRAIDING MACHINES, E. A. Claremont and J. Stratton, Manchester.
13,396. INCANDESCENT SPIRIT LAMPS, L. Llais, Manchester.
13,397. TRACTORS for AERIAL MACHINES, W. MacLeod, London.
13,398. FIELD SERVICE BOILER, F. W. Holdaway, Winchester.
13,399. PORTABLE GRINDING MACHINES, W. Poole, Glasgow.
13,400. FIRE-ESCAPES, W. Aitken, London.
13,401. METALLIC ALLOYS, S. Willington and M. C. Chandor, London.
13,402. ERECTING LADDER PLATFORMS, P. Leigh, London.
13,403. PREVENTING REFILLING of BOTTLES, E. C. Halson, London.
13,404. INCANDESCENT MANTLE SUPPORTS, T. Anderton, Hollinwood, Lancs.
13,405. BOX for AUTOMATIC DELIVERY of CIGARS, P. Hensel and F. J. Zelzer, London.
13,406. CHAIRS, C. E. Stares, London.
13,407. GAME, F. C. Pinyoun, London.
13,408. CAPSULE for AERATING LIQUIDS, S. H. Crocker, London.
13,409. SYPHON for AERATING WATER, S. H. Crocker, London.
13,410. POST SOCKET, F. Gripper and F. Watts, Ilford.
13,411. BENCH STOPS, The Steel Nut and J. Hampton, Limited, and J. Hampton, sen., London.
13,412. FITTING LIDS in MILK CANS, A. Bratt, Birmingham.
13,413. HORSESHOE-MAKING MACHINE, J. McKenzie, London.
13,414. APPARATUS for ADVERTISING, M. W. Lowinsky, London.
13,415. MINIATURE RIFLE RANGE, G. E. Goddard, Pewsey, Wiltshire.
13,416. PREPARATIONS of CASTOR OIL, L. F. Riedel, London.
13,417. PROPELLER MECHANISM for BOATS, H. Schück, C. Linley, and S. Lee, London.
13,418. PROPELLER MECHANISM for BOATS, C. Linley and S. Lee, London.
13,419. PROPELLERS for SHIPS or BOATS, S. Lee, London.
13,420. ROTARY ENGINE, T. Millward and H. I. Pringle, London.
13,421. TYPEWRITER COVERS, The Yöst Typewriter Company, Limited, and S. W. Turner, London.
13,422. HEARTHSTONE, J. D. Brown, London.
13,423. PNEUMATIC TIRES, C. H. Burt, London.
13,424. SAFETY ATTACHMENT for VEHICLES, C. H. Burt, London.
13,425. REEL-CARRYING APPARATUS, G. W. Mascord London.
13,426. BOTTLE-FILLING MACHINE, J. McLaren, Dalton-in-Furness, Lancs.
13,427. APPARATUS for EMBOSSING LABELS, T. Hawkins, London.
13,428. ATTACHING CARS to CYCLES, I. Christmas, London.
13,429. BROMO-SUBSTITUTION PRODUCTS, O. Imray.—*(Farbwerke vormals Meister, Lucius und Brüning, Germany.)*
13,430. BROMINATION PRODUCTS of INDIGO, O. Imray.

—(*Farbwerke vormals Meister, Lucius und Brüning, Germany.*)
13,431. RANGE FINDING PRACTICE, S. W. Edmund, London.
13,432. SOLES of BOOTS, The Phœnix Boot Machinery Company, Limited.—(*J. Keatz, Austria.*)
13,433. IMPROVED SWIMMING APPARATUS, W. H. Butler, London.
13,434. SKYLIGHTS, J. Steinkühler, London.
13,435. POCKET QUADRANTS, C. Gettliffe, London.
13,436. FISHING RODS, W. M. Bruine, London.
13,437. MACHINE TOOLS, J. L. Osgood, London.
13,438. ELECTRIC RAILWAY SYSTEMS, H. H. Lake.—(*T. E. Murray and J. van Vleck, United States.*)
13,439. PUMPS for AIR COMPRESSORS, G. Stevenson, Liverpool.
13,440. MANUFACTURE of BELTINGS, P. C. D. Castle, Liverpool.
13,441. LENSES, C. A. H. Harting, Liverpool.
13,442. MEASURING the INTENSITY of LIGHT, W. Frisby, Liverpool.
13,443. WRENCH, R. J. Cosseboom and L. M. Smith, London.
13,444. VESSELS, W Pirrie, London.
13,445. SCREW PROPELLERS, F. W. Lanchester, London.
13,446. COMBUSTION ENGINES, F. W. Lanchester, London.
13,447. FUEL, J. C. Berntrop and M. L. Q. Van L. Hulsebosch, London.
13,448. TWISTING and SPINNING MACHINES, A. Klein, London.
13,449. SUPPORT for RAILWAY RAILS, D. L. Hutchison, London.
13,450. SUPPORT for RAILWAY RAILS, D. L. Hutchison, London.
13,451. COMPRESSING LIQUID STEEL, H. Harmet, London.
13,452. ANTI-VIBRATION DEVICE, J. M. M. Truffault, London.
13,453. FOLDING BABY CARRIAGE and CHAIR, W. J. Rose, London.
13,454. SUPPORTING RODS for CURTAINS, C. R. Barrett, London.
13,455. DRYING MATERIAL, H. J. Haddan.—(*E. R. Elson, United States.*)
13,456. OPERATING GATES for RAILWAY CARS, E. E. Gold, London.
13,457. DOUBLE SEAMING MACHINES, O. Stern-ff-Beyer, London.
13,458. CUTTING SHEETS of CARDBOARD, C. Johnson, London.
13,459. CLOCKS, J. Reichenberg, London.
13,460. MEASURING APPARATUS, W. L. Wise.—(*The Compagnie Parisienne d'Eclarage et de Chauffage par le Gaz, France.*)
13,461. LAYING the DUST in TUNNELS, C. H. Sanders, London.
13,462. SHEARING MACHINES, R. Allen, London.
13,463. LAMPS, J. W. T. Cadett and E. S. Shepherd, London.
13,464. INDICATING TEMPERATURE of MOLTEN LEAD, H. D. Phillips, London.

14th June, 1902.

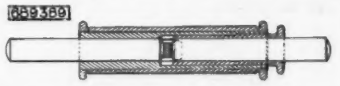
13,465. CAMERA DARK SLIDES, J. Boylan, Bradford.
13,466. FASTENINGS for GLOVES, W. Parkinson, Manchester.
13,467. LOOM MOTION, A. Cheetham, Middleton Junction, near Manchester.
13,468. REFLECTING LENS, W. N. L. Davidson, London.
13,469. SEATS for OUTDOOR PURPOSES, F. J. Smedley, Manchester.
13,470. SASH FASTENER for WINDOWS, E. Banfield, Brighton.
13,471. PRINTING with SULPHUR DYES, R. J. Urquhart.—(*The Chemische Fabriken vorm. Weiler-ter Meer, Germany.*)
13,472. PISTON PACKING RING, A. Hart, Manchester.
13,473. COLOURED SPINNING TOPS, T. Ansboro, Glasgow.
13,474. TESTING of WEIGHBRIDGES, J. Holt, Manchester.
13,475. CONNECTING TRAILER to the SEAT PILLAR of a BICYCLE, J. W. Milligan and J. W. Bayliss, Birmingham.
13,476. PRODUCING PRINTING TYPE, R. F. Ballantine, Bristol.
13,477. HEELS of BOOTS and SHOES, J. Thomas, Bristol.
13,478. MATCH STRIKERS, C. L. Hoppe, Water Orton, Warwickshire.
13,479. QUICK LOADER for REVOLVERS, The Webley and Scott Revolver and Arms Company, Limited, and W. J. Whiting, Birmingham.
13,480. COOLING WATER, H. Cliff and F. Wainwright, Nottingham.
13,481. RUNNING GAS SERVICE MAINS, W. Tylar, Birmingham.
13,482. SEALING DEVICE for BOTTLES, C. F. England, Bristol.
13,483. CLIPS, The Calico Printers' Association, Limited, and W. Warr, Manchester.
13,484. HIGH-PRESSURE STOP VALVES, The Scotch and Irish Oxygen Company, Limited, and J. L. Carty, Glasgow.
13,485. GAME of CRICKETELLE, G. Harding, Wordsley, near Stourbridge.
13,486. RUG CARRIERS, W. H. Boyd, Flixton, near Manchester.
13,487. SPLASH PREVENTER for TAPS, W. M. Jones, Sheffield.
13,488. COTTON GINS, A. M. Dastur, Manchester.
13,489. SIGNAL LAMPS for VEHICLES, G. Sidney, Liverpool.
13,490. REVERSING GEAR for SHAFTING, H. S. Hele-Shaw, Liverpool.
13,491. SWITCH for TELEPHONES, H. R. Webb, Nottingham.
13,492. CYCLE-DRIVING MECHANISM, C. G. Garrard, London.
13,493. SECURING SCAFFOLDING POLES, C. Steffgen, London.
13,494. KNIFE-CLEANING MACHINE, F. Hansing, London.
13,495. MANTLES, L. Hicks, New York City, United States.
13,496. MOTOR VEHICLE SPRAY, A. G. and H. H. Castell, London.
13,497. COVERS for RACES of SHUTTLES, H. Mundlos, London.
13,498. RACKS for SEWING MACHINE SHUTTLES, H. Mundlos, London.
13,499. FLYING MACHINE, A. K. R. A. Krakow, London.
13,500. COMMUTING CURRENT, C. E. and H. M. Peel, Limited, Swansea.
13,501. ACCIDENT-PREVENTING APPARATUS, T. Lobley, London.
13,502. STRETCHER for TROUSERS, J. E. C. Maryon, London.
13,503. LUBRICATING AXLES, A. A. Peart, Kingston-on-Thames.
13,504. FURNITURE, F. J. Bullock and T. Harford, Kingston-on-Thames.
13,505. EXCAVATORS, H. G. Butler, Kingston-on-Thames.
13,506. FASTENING WEARING APPAREL, G. Wildman, London.
13,507. LACING BOOTS and SHOES, A. W. Powell, London.
13,508. WATER PURIFIERS, &c, F. Delmouly, London.
13,509. COAL-CUTTING MACHINES, H. B. Edwards, London.
13,510. RAIL POINTS, P. U. Askham and W. Marshall, Sheffield.
13,511. OBTAINING LIGHT RADIATION, A. Walker, Hounslow, Middlesex.
13,512. HEATING LIQUIDS of LOW BOILING POINTS, V. F. Feeny.—(*Abwärme-Kraftmaschinen-Gesellschaft m. b. H., Germany.*)
13,513. STEAM CONDENSER, O. H. Bayldon, London.
13,514. OPTICAL SIGHTS for SMALL ARMS, A. A. Common, London.
13,515. FIRE-ESCAPE, T. W. Hill, London.
13,516. BABIES' FEEDING BOTTLES, G. F. Boling, London.
13,517. MOTORS, E. C. A. Andreen and O. Stalhane, London.
13,518. BELLS, H. de M. Wellbourne, A. E. Hall, and W. Knight, London.
13,519. MOTOR ROAD VEHICLES, W. H. Buxton, Liverpool.
13,520. BICYCLES, A. Sommer, Liverpool.
13,521. COHERERS, O. J. Lodge, A. Muirhead, and E. E. Robinson, London.
13,522. PRESERVING VEGETABLE SUBSTANCES, R. Scott, London.
13,523. STOPPERS for BOTTLES, E. F. Roberts, London.
13,524. TOY, C. Lopdell, London.
13,525. CUFF HOLDERS, P. Jakobi, London.
13,526. OPERATING COUNTERSHAFTS, The British Thomson-Houston Company, Limited.—(*N. C. Bassett, United States.*)
13,527. MEASURING INSTRUMENTS, The British Thomson-Houston Company, Limited.—(*L. T. Robinson, United States.*)
13,528. INERTIA DAMPERS, The British Thomson-Houston Company, Limited.—(*W. H. Pratt, United States.*)
13,529. ELECTRIC-STARTING RHEOSTATS, The British Thomson-Houston Company, Limited.—(*C. E. Harthan, United States.*)
13,530. BRUSH HOLDERS, The British Thomson-Houston Company, Limited.—(*N. C. Bassett, United States.*)
13,531. ELECTRIC SWITCHES, The British Thomson-Houston Company, Limited.—(*H. Geisenhoner, United States.*)
13,532. ELECTRIC CONDENSERS, The British Thomson-Houston Company, Limited.—(*W. S. Moody, United States.*)
13,533. ARMATURE BANDS, The British Thomson-Houston Company, Limited.—(*J. J. Wood, United States.*)
13,534. MOTOR-CONTROL SYSTEMS, The British Thomson-Houston Company, Limited.—(*C. E. Barry, United States.*)
13,535. DRIVING GEAR for CAMS, W. Hartmann, London.
13,536. PREPARING LIME, The Castner Kellner Alkali Company, Limited, A. T. Smith, and H. Baker, London.
13,537. FURNACES for SUPERHEATERS, J. Björnstad, London.
13,538. OPERATING DOORS, F. G. P. Preston and G. C. Ralston, London.
13,539. ELECTRIC WIRES, &c, W. H. Hyatt, London.
13,540. SPEED GEAR, —. Durieu, —. Trépreau, and —. Lagarde, London.
13,541. SMOKE-CONSUMING APPARATUS for BOILERS or FURNACES, C. G. Bracklow, H. G. E. Timm, and H. Bünz, London.
13,542. FACILITATING SHIP PROPULSION, G. Quanonne, London.
13,543. MANURE-SPREADING APPARATUS, W. Wiechelt, London.
13,544. RELEASING HORSES from VEHICLES, V. Szabady, London.
13,545. LAMPS, K. Weinert, London.
13,546. HOLDING SHOES whilst being WORKED, G. Lück, London.
13,547. SUGAR-MAKING MACHINERY, F. Hampl, London.
13,548. BRAKE APPARATUS for WAGONS, R. G. Miller, London.
13,549. MANUFACTURE of STAIR ROD EYES, J. Earle, London.
13,550. EXPANDING BOILER TUBES, H. D. Mar, London.
13,551. CIGARETTE-MAKING MACHINES, G. L. Tillmanns, London.
13,552. SPINNING MACHINERY BOBBINS, V. Bélanger, London.
13,553. HANDLE BARS for BICYCLES, H. M. Salmony, London.
13,554. ROLLABLE PHOTOGRAPHIC FILMS, G. Mitchell, London.
13,555. MANUFACTURE of FOLDED STRIPS of TEXTILE MATERIAL, Hirschfeld Bros. and R. E. Schönfeld, London.
13,556. CONTROLLING ELECTRICITY SUPPLY, C. Ilgner, London.
13,557. WATER-TUBE STEAM GENERATORS, R. H. H. Marsh, London.
13,558. TUNING PIANOFORTES, F. A. A. Robinson, London.
13,559. HAIR PINS, A. T. Danyell, London.
13,560. TOY, A. J. Danyell, London.
13,561. DOOR or WINDOW WEDGE, A. E. Woods, London.
13,562. KEYS for PIANOFORTES, L. F. Papps, London.
13,563. ATTACHING OUTFIT BOX to CYCLES, W. H. Horton, Birmingham.
13,564. FOUNTAINS, F. de Mare, London.

SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

689,389. APPARATUS FOR THE PRODUCTION OF ACCURATE GAUGES, *O. Eckelt, Berlin, Germany.—Filed January 17th*, 1901.

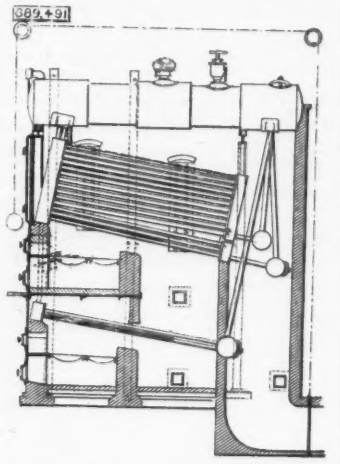
Claim.—An improved apparatus for the production of accurate gauges variable at will, the same consisting



of two removable—or interchangeable—rod-shaped end measures held in the same axial line and combined with flat measures interposed between the end measures, bringing the total measure up to that which is to be produced.

689,491. STEAM GENERATOR, *W. Hornsby, D. Roberts, and C. James, Grantham, England.—Filed March 20th*, 1901.

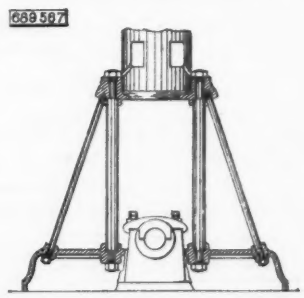
Claim.—(1) In a steam generator, the combination with the steam drum, of a water-tube section having a single header at one end and at the other end two headers located one above the other and independent connections extending from said heaters directly to said steam drum, substantially as described. (2) In a steam generator, the combination with the steam drum, of a water-tube section comprising a single



front header, two rear headers located one above the other, and water tubes connected to the front header, a portion of said tubes being connected to the upper rear header and a portion to the lower rear header, a separate mud-drum for each of said rear headers, connections between the front header and the steam drum, separate connections from each of said mud-drums to the steam drum, a furnace below said water-tube section, a lower water-tube section below said furnace provided with a header connected with the upper water-tube section, and a mud-drum directly connected to the steam drum, and a lower furnace below said lower water-tube section, substantially as described.

689,567. ENGINE FRAME, *J. A. Secor, Brooklyn, N.Y.—Filed September 11th*, 1900.

Claim.—An engine frame comprising in combination a bed-plate having vertical sockets and oblique bores, a cylinder having vertical sockets and outwardly-extended lugs in which are oblique screw-thread bores, vertical standards which have their shouldered upper and lower ends inserted in and shouldered on the shoulders of the vertical sockets of the cylinder and



bed-plate respectively, oblique tension braces which are screw-threaded at their opposite ends, each with its upper end screwed into a threaded oblique bore of a cylinder lug and with its lower end passed through and projected below a correspondingly oblique bore in the bed-plate, and nuts upon the lower extremities of the straining braces and standards to tighten the same and compress the cylinder upon the standards, substantially as herein set forth.

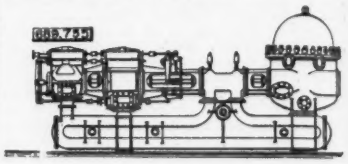
689,688. CORRUGATED BOILER FURNACE OR FLUE, *J. Nodder, Sheffield, England.—Filed May 24th*, 1901.

Claim.—(1) The herein-described method of manufacturing corrugated boiler furnaces or flues, consisting of rolling a flat plate with corrugations of great thickness and alternating flat portions of less thickness, such thickness gradually decreasing from the corrugations to the flat portions and then forming the plate so rolled into a cylindrical boiler flue with the flat portions parallel with the axis of the flue, substantially as described. (2) As a new article of manufacture, the herein-described cylindrical corrugated boiler furnaces or flues, consisting of a plate having corrugations and flat portions, parallel with the axis of the flue alternating with the corrugations, the parts of

largest diameter being of the greatest thickness and the parts of smallest diameter being of the least thickness, the thickness gradually increasing from the parts of smallest diameter to those of largest diameter, substantially as described.

689,775. NON-ROTATIVE PUMPING ENGINE, *L. d'Auria, Philadelphia, Pa.—Filed July 21st*, 1899.

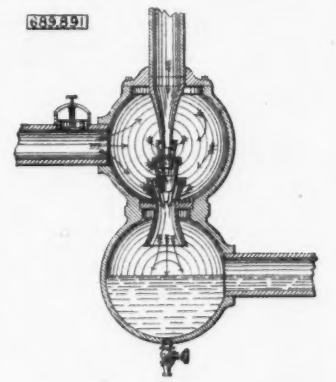
Claim.—A direct-acting pumping engine, having a compensator with flow pipe for containing a mass of



liquid, said flow pipe being disposed beneath the cylinder structure of the engine and serving as a support or foundation therefor, substantially as specified.

689,891. SYPHON CONDENSING EJECTOR, *W. D. Labadie, South Bend, Ind.—Filed January 7th*, 1901.

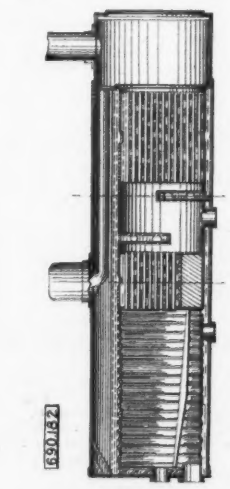
Claim.—In a syphon condensing ejector, a shell or frame divided into two chambers, the upper one of which is provided with a removable cap through which a water-inlet pipe extends, an exhaust steam



pipe connected to the upper chamber and provided with a safety valve, and a discharge pipe connected to the lower chamber, combined with a series of perforated cones removably mounted between the chambers, and through which the exhaust steam is entrained.

690,182. LOCOMOTIVE BOILER, *J. J. Regan, Jersey City, N.J.—Filed June 6th*, 1901.

Claim.—A steam boiler comprising an external shell, an internal shell disposed longitudinal within said external shell, excentrically thereto, and forming a



water and steam compartment which surrounds said internal shell, the last-named shell being divided into a primary combustion chamber, an auxiliary combustion chamber, and other chambers which are equipped with independent sets of smoke flues.

END OF VOL. XCIII.

The Engineer.

Registered as a Newspaper

OFFICE FOR ADVERTISEMENTS AND PUBLICATION, 33, NORFOLK STREET, STRAND, W.C.

VOL. XCIII.—No. 2426] LONDON: FRIDAY EVENING JUNE 27, 1902. [PRICE {WITH SUPPLEMENT} SIXPENCE

Warning.—To Makers and Users OF POWER PRESSES OR LIKE MACHINES FOR DRAWING OR STAMPING METALLIC SEAMLESS HOLLOW-WARE.—TAYLOR and CHALLEN, Limited, of Birmingham, Engineers, WILL INSTITUTE IMMEDIATE LEGAL PROCEEDINGS AGAINST INFRINGERS (whether as makers or users) of any of their several patents relating to above.

SAUNDERS, BRADBURY & SAUNDERS,
37, Temple-row, Birmingham,
Solicitors for Taylor and Challen, Limited.
1724a

King's College, London.—The Council invite APPLICATIONS for the following APPOINTMENTS:—

(1) ASSISTANT PROFESSOR OF ENGINEERING.
(2) ASSISTANT DEMONSTRATOR IN ENGINEERING.
(3) LECTURER IN MATHEMATICS.

Applications should be sent in by Monday, July 14th.
For further particulars apply to the Secretary.

WALTER SMITH,
Secretary.
2250

Naval Architecture.—Wanted, a LECTURER in NAVAL ARCHITECTURE for both Day and Evening Classes.

Must be thoroughly competent; academical rank preferred. Commencing salary, £200 per annum.

Applications and testimonials must be sent in not later than July 24th, 1902, to

THE SECRETARY,
The Durham College of Science,
Newcastle-upon-Tyne.
2263

Bombay, Baroda, and Central India Railway Company.

The Directors are prepared to receive up to noon on Tuesday, the 8th July, TENDERS for the SUPPLY of the following STORES, viz.:—

(1) Brass Boiler Tubes.
(2) Flanged and Plain Copper Plates.
(3) Steel Material.

Tenders must be made on forms, copies of which, with specifications, can be obtained at these offices on payment of 5s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

T. W. WOOD,
Secretary.

Offices: Gloucester House,
Bishopsgate-street Without, London, E.C.,
24th June, 1902.
2287

City and County Borough of Chester.

CONSTRUCTION AND RECONSTRUCTION, AND ELECTRICAL EQUIPMENT OF TRAMWAYS; ALTERATION, ADAPTATION, AND EQUIPMENT OF SHED; TRAMWAY CARS; AND GENERAL EQUIPMENT.

The Corporation is prepared to receive TENDERS for ABOVE, preferably for the whole, or in sections, viz.:—

(A) Permanent Way Construction (length of route about 4678 yards) and Car Shed.
(B) Bonds.
(C) Overhead Equipment.
(D) Cars.

The drawings and specifications may be inspected on and after the 23rd instant at the Town Hall, on application to I. M. Jones, Esq., City Surveyor, Town Hall, or F. Thursfield, Esq., City Electrical Engineer, New Crane-street, from either of whom a copy of the specification and form of Tender may be obtained, on payment of £3 3s., which will be returned if a bonâ fide Tender be sent in.

The Corporation do not bind themselves to accept the lowest or any Tender.

Sealed Tenders, on the form supplied, and endorsed "Tramways," must reached the undersigned on or before 10 a.m. on the 7th July next.

SAML. SMITH,
Town Clerk.

Town Hall, Chester,
June, 17th, 1902.
2238

Corporation of Leicester.—Gas-HOLDER.

CONTRACT No. 72.

The Gas and Electric Lighting Committee of the above Corporation are prepared to receive TENDERS for the SUPPLY and ERECTION of a THREE-LIFT TELESCOPIC GAS-HOLDER, 197ft. 8in. diameter, at their Aylestone-road Works. Tenders, addressed to Mr. Councillor Edwards, Chairman, and endorsed "Tender for Gasholder," to be delivered at these offices not later than 11 o'clock a.m. on Monday, July 14th, 1902.

The Committee do not bind themselves to accept the lowest or any Tender.

ALFRED COLSON, M. Inst. C.E., M. Inst. E.E.,
Engineer and Manager.

Offices: Millstone-lane, Leicester,
June 21st, 1902.
2271

Manchester Corporation Waterworks.

THIRLMERE AQUEDUCT.
SECOND LINE OF PIPES.
CONTRACT No. 15.
AUTOMATIC AND REFLUX VALVES.

The Waterworks Committee invite TENDERS for the SUPPLY of AUTOMATIC STOP VALVES, 40in. and 36in. diameter, REFLUX VALVES, 44in. and 40in. diameter, MOMENTUM VALVES, 18in. diameter. Anchoring Arrangements, Cast Iron Cover Plates, and a few other items of Ironwork.

Printed specifications and forms of Tender may be obtained, and drawings may be seen, on and after Monday, the 16th inst., at the offices of Messrs. G. H. Hill and Sons, Civil Engineers, 3, Victoria-street, Westminster, and Albert-chambers, Albert-square, Manchester, on receipt of cheque for One Guinea, which will be returned on receipt of a bonâ fide Tender after the Committee have come to a decision upon the Tenders, and on return of the documents lent for making up the Tender.

Sealed Tenders, endorsed "Tender for Automatic and Reflux Valves," and addressed to the Chairman of the Waterworks Committee, must be forwarded to the Secretary, Waterworks Offices, Town Hall, Manchester, on or before Monday, the 30th June, 1902.

The Committee do not bind themselves to accept the lowest any Tender.

By order,
WM. HENRY TALBOT,
Town Clerk.

Town Hall, Manchester,
12th June, 1902.
2199

HARBOUR CONSTRUCTION.

Tenders will be Received at the office of the Engineer-in-Chief, Adelaide, South Australia, up till noon of Tuesday, the 30th September, for the CONSTRUCTION of a HARBOUR at Light's Passage, Port Adelaide, South Australia.

Drawings and specification can be seen and forms of Tender obtained at the offices of the Engineer-in-Chief, Adelaide, and at the office of the Agent-General for South Australia, 1, Crosby-square, London.

Copies of the drawings and specification can be obtained on the payment of the sum of £5 per set, which amount will be returned to unsuccessful tenderers, who have sent in a bonâ fide Tender, on return of the documents in good condition within one week from date of notice of non-acceptance of Tender.

Tenders should be endorsed "Tender for Harbour, &c., Port Adelaide," and must be accompanied by an Adelaide bank deposit receipt for £100, or a cheque on an Adelaide bank for a like amount marked "Good for a Week," in favour of the Engineer-in-Chief.

Neither the lowest nor any Tender necessarily accepted.

H. ALLERDALE GRAINGER,
Agent-General.
2189

Wanted, by a Glasgow Firm, a steady man, with special experience in tools and millwright work, as ASSISTANT FOREMAN for Constructional Ironwork, Gates, Railings, &c. A suitable man will have every encouragement.—Apply in first instance, stating age, salary, &c., to FOREMAN, W. Forteous and Co., Glasgow. P543

TO STEEL CABLE MANUFACTURERS AND OTHERS.

The London County Council is prepared to receive TENDERS for the MANUFACTURE and SUPPLY of TWO STEEL CABLES, one 30,000ft. and the other 9400ft. in length, for use in connection with the Council's cable tramways at Streatham.

Persons desiring to submit Tenders may obtain the specifications and form of contract at the Engineer's Department, County Hall, Spring-gardens, S.W.

Tenders must be upon the official forms, and the printed instructions contained therein must be strictly complied with.

The contractors will be bound by the contract to pay to all workmen (except a reasonable number of legally-bound apprentices) employed by them wages at rates not less and to observe hours of labour not greater than the rates and hours set out in the Council's list, and such rates of wages and hours of labour will be inserted in and form part of the contract by way of schedule.

Each Tender for the supply of one or both of the cables is to be delivered at the County Hall, in a sealed cover, addressed to the Clerk of the London County Council, Spring-gardens, S.W., and marked "Tender for Steel Cable—L.C.C. Tramways."

No Tender will be received after 10 o'clock a.m. on Thursday, the 10th day of July, 1902.

Any Tender which does not comply with the printed instructions for Tender may be rejected.

The Council does not bind itself to accept the lowest or any Tender, and it will not accept the Tender of any person or firm who shall on any previous occasion have withdrawn a Tender after it had been opened, unless the reasons for the withdrawal were satisfactory to the Council.

G. L. GOMME,
Clerk of the Council.

County Hall, Spring-gardens, S.W.,
25th June, 1902.
2275

TO MAKERS OF OVERHEAD TRAVELLING CRANES.

The London County Council is prepared to receive TENDERS for the MANUFACTURE, DELIVERY, and ERECTION of ONE ELECTRIC-POWER OVERHEAD TRAVELLING CRANE, to lift 25 tons, THREE HAND-POWER OVERHEAD TRAVELLING CRANES, to lift 10 tons each, at certain of the Council's depôts in the south of London.

Persons desiring to submit Tenders may obtain the specification, schedule of quantities, form of Tender, and other particulars, at the County Hall, Spring-gardens, S.W., upon payment of the sum of Two Pounds.

This amount will, after the Council or its Committee shall have come to a decision upon the Tenders received, but not before, be returned to the Tenderer, provided he shall have sent in a bonâ fide Tender and not have withdrawn the same.

Tenders must be upon the official forms, and the printed instructions contained therein must be strictly complied with.

The contractors will be bound by the contract to pay to all workmen (except a reasonable number of legally-bound apprentices) employed by them wages at rates not less and to observe hours of labour not greater than the rates and hours set out in the Council's list, and such rates of wages and hours of labour will be inserted in and form part of the contract by way of schedule.

Each Tender is to be delivered at the County Hall, in a sealed cover, addressed to the Clerk of the London County Council, Spring-gardens, S.W., and marked "Tender for Travelling Cranes—L.C.C. Tramways."

No Tender will be received after 10 o'clock a.m. on Tuesday, the 15th day of July, 1902.

Any Tender which does not comply with the printed instructions for Tender may be rejected.

The Council does not bind itself to accept the lowest or any Tender, and it will not accept the Tender of any person or firm who shall on any previous occasion have withdrawn a Tender after it had been opened, unless the reasons for the withdrawal were satisfactory to the Council.

G. L. GOMME,
Clerk of the Council.

County Hall, Spring-gardens, S.W.,
25th June, 1902.
2274

TO ENGINEERS AND OTHERS.

The Metropolitan Asylums Board invite TENDERS for the PROVIDING and FIXING of a complete LAUNDRY PLANT, including Engines, Machinery, Feed-water Heater, Fittings and Shafting, &c., at Joyce Green Hospital, Dartford, Kent, in accordance with drawings and specification prepared by the Engineer to the Board.

Drawings, specification, conditions of contract, schedule of materials, and form of Tender, may be obtained at the office of the Board, Embankment, E.C., on and after Monday, the 30th June, upon payment of a deposit of £5.

The amount of the deposit will be returned to persons who have sent in bonâ fide Tenders in accordance with the regulations.

Tenders, addressed as noted on the form of Tender, must be delivered at the office of the Board not later than 10 a.m. on Wednesday, the 16th July, 1902.

(By order)
T. DUNCOMBE MANN,
Clerk to the Board.

23rd June, 1902.
2279

Urban District Council of Southborough.

WATERWORKS, CONTRACT No. 2.
PUMPING STATION, AERATING TANKS, FILTER BEDS, AND PUMPING MAIN.

The Urban District Council of Southborough, Kent, are prepared to receive TENDERS from competent persons willing to enter into a contract for the CONSTRUCTION of a PUMPING STATION at Upper Hayaden, in the Parish of Bidborough, about 2¼ miles south-west from Tonbridge Station, comprising an Engine-house, Boiler-house, Coal Store, and Chimney, Machinery, foundations for, and the erection of a duplicate set of Engines, Deep Well Pumps, and Ram Pumps; and also an Aerating Tank, Three Sand Filters, and a Pure Water Reservoir, together with all Valves and Connections; and a line of 8in. Pumping Main, about 2¼ miles in length, to the existing Reservoir, at Southborough.

The drawings and specification may be seen at the Council Offices, Southborough, and at the Loughborough Office of the Engineers, Messrs. George and F. W. Hodson, from whom a copy of the schedule of quantities may be obtained after the 30th June, on deposit of a cheque for £5 5s., which will be returned after a contract has been entered into, to every person making a bonâ fide Tender on the return of the documents entrusted to them.

In the event of a Tender being withdrawn the deposit will be forfeited.

Sealed Tenders, on the prescribed form, endorsed "Waterworks, Contract No. 2," are to be sent to the undersigned, to be received not later than mid-day on Friday, the 25th day of July, 1902.

The Council do not bind themselves to accept the lowest or any Tender.

Dated this 21st day of June, 1902.

PHILIP HANMER,
Clerk to the Council.

Council Offices, Southborough,
Near Tunbridge Wells.
2278

City of Liverpool.—Superintendent of Baths and Wash-houses.

The Corporation of Liverpool REQUIRE the SERVICES of a MARRIED MAN as WORKING SUPERINTENDENT of Burroughs-garden Baths and Wash-houses.

Applicants must have a practical knowledge of mechanical engineering, and be able to execute repairs.

Salary, £130 per annum, increasing £10 per annum until it reaches £150 per annum, subject to a contribution of £3 per cent. to the Corporation Superannuation Fund; and the person appointed will be required to prove to the satisfaction of the Controller and Auditor of Accounts that he has effected an insurance on his life to an amount, the premium on which is equal to 2 per cent. of his salary, and to a deduction of £30 for house, coal and gas, which will be provided.

The wife of the person appointed will be required to act as Working Matron without salary.

Applications, stating age, with copies of testimonials, and endorsed "Superintendent of Baths and Wash-houses," to be sent to the Town Clerk, Municipal Offices, Liverpool, not later than the 15th day of July, 1902.

Particulars of the duties may be obtained on application.

Canvassing members of the Council, either directly or indirectly, is a disqualification.

EDWARD R. PICKMERE,
Town Clerk.

Town Clerk's Office,
Liverpool,
19th June, 1902.
2268

Stepney Union.—The Guardians REQUIRE an ENGINEER for their Children's Homes at Stifford, Essex.

Candidates must be thoroughly competent to take charge of the boilers, engines, electric lighting and other machinery; also the heating and fire-extinguishing apparatus, to execute or superintend the execution of all repairs thereto, or to the water service.

Candidates must be married men between 30 and 40 years of age.

Salary, £2 per week, with unfurnished residence, fuel and light, subject to the deductions authorised by the Poor Law Officers Superannuation Act, 1896.

Printed forms of application, containing further details as to duties (and which alone can be received), may be obtained at my office as below, and these forms duly filled in must be returned to me on or before 23rd July next.

By order,
S. A. LEWIS,
Clerk.

Guardians' Offices, Barnes-street,
Ratcliffe, London, E.,
19th June, 1902.
2286

Wanted, for a High-class and well-known Machine Tool Works in Manchester, employing about 400 men, a GENTLEMAN of experience to TAKE the POSITION of MANAGER or MANAGING DIRECTOR; good position and good salary.—Apply to C. R. WESTERN, Broadway-chambers, Westminster, S.W. P544

Works Manager Required in the Midlands for the Manufacture of Large Medium-speed Engines; must be an experienced engineer of good standing and exceptional ability, and able to take complete charge of estimating, drawing-office, and works. A man with good marine experience would probably suit. Must be thorough organiser, capable of obtaining maximum rate of output. To such a man liberal salary and first-class opening will be offered. —Address, stating age, experience, salary, references, and full particulars, 2262, Engineer Office, 33, Norfolk-street, Strand, W.C. 2262

Wanted, a Draughtsman for Jigs, Tools, and Shop Plant.—Apply, stating full experience, age, and salary required, to ALFRED HERBERT, Limited, Coventry. 2258

Wanted, by a Leading Firm in Manchester, smart, capable DRAUGHTSMAN, to be well up in gearing, with a knowledge of electric traction. State age, experience, and salary expected. Good opening.—Address, "D 18," care of W. H. Smith and Son, Advertising Agents, Manchester. 2226

Wanted for Lisbon (Portugal), JUNIOR DRAUGHTSMAN, about 19 years of age, to prepare drawings from sketches; must be quick, neat, and accurate. Passage paid.—Send full particulars to EMPREZA INDUSTRIAL PORTUGUEZA, Lisbon. 2260

Wanted, in London, Engineer's DRAUGHTSMAN; one accustomed to steel construction work and with some electrical knowledge preferred; commencing salary, £160, with annual increase to suitable man. Reply, stating age, experience, with full information as to past employment.—Address, P547, Engineer Office, 33, Norfolk-street, Strand, W.C. P547

Wanted, Junior Draughtsman; must be accustomed to making out details.—Apply, BRISTOL WAGON and CARRIAGE WORKS COMPANY, Ltd., Lawrence Hill, Bristol, stating qualifications and salary required. 2256

Draughtsman. — Leading DRAUGHTSMAN WANTED by an Engineering Firm in the West of Scotland, engaged chiefly in steel works and colliery plant.—Applications, with full particulars, to be sent in the first instance to 2267, Engineer Office, 33, Norfolk-street, Strand, W.C. 2267

Draughtsman Wanted for Con-SULTING Engineer's Office in Glasgow; those experienced in heating and ventilating preferred. State salary expected.—Apply, 800, Porteous and Company, Glasgow. P548

Draughtsman Wanted in London Electrical Firm; state experience, age, and wages at last situation, and whether at present disengaged. Commencing salary 30s. weekly.—Address, Box E, Chas. Tayler and Co.'s Advertisement Offices, 154-157, Fleet-street, E.C. 2265

Draughtsman Wanted; Subject: Internal Combustion Engines.—Apply, MARTIN, 50, Cannon-street, E.C. 2263

Railway Signalling. — Junior DRAUGHTSMAN (having good mechanical knowledge) REQUIRED in the Signalling Department of one of the English railways. One with shop training preferred.—Address, stating experience, age, salary required, &c., 2280, Engineer Office, 33, Norfolk-street, Strand, W.C. 2280

Small Tools.—Wanted, Draughtsman, with special experience in small tools, jigs, fixtures, and gauges.—Apply, giving full particulars of experience, salary required, &c., ALFRED HERBERT, Limited, Coventry. 2224

Wanted, an Experienced Engi-NEER-REPRESENTATIVE for Mechanical Ventilation; only those who have had previous knowledge need apply.—Address, 2251, Engineer Office, 33, Norfolk-street, Strand, W.C. 2251

Wanted, Representative for ENGLAND by Manufacturers of first-class Hot-water Heater and Low-pressure Steam Boiler.—Address, H. M. 2131, care of Neyroud and Son's Advertising Offices, 14-18, Queen Victoria-street, London, E.C. 2281

Wanted Temporarily, with the prospect of permanency, by a London firm manufacturing waterworks specialities, a REPRESENTATIVE having a large connection among Waterworks Consulting Engineers in London; part of his time would suffice; salary and commission; replies will be considered strictly confidential.—Address, 2268, Engineer Office, 33, Norfolk-street, Strand, W.C. 2268

Wanted, Patternmaker at Once, a good leading hand, expert at laying out special spigot and socket pipes in loam and dry sand.—State age, experience, references, and wages required to 2269, Engineer Office, 33, Norfolk-street, Strand, W.C. 2269

Electrical and Mechanical Work-ING ENGINEER WANTED, to TAKE CHARGE of Plant, &c., of a large works near Manchester; must thoroughly understand electric lighting, including inverted arc lamps, generating plant, and electric-geared motors, and be able to keep same in thorough working order; also capable of superintending high-pressure steam engines, boilers, and heating apparatus, and repairs to same.—Applications, endorsed "Electrical Engineer," stating age, experience, and salary required, to be forwarded not later than Monday, June 30th, addressed to the COMMITTEE, Co-operative Wholesale Society, Limited, 1, Balloon-street, Manchester. 2210

Patternmakers, Three or Four good steady hands, accustomed to general engineering and pipe work.—Address, 2270, Engineer Office, 33, Norfolk-street, Strand, W.C. 2270

Turner and Fitter Wanted for General Repairs on small country Waterworks; must be good all-round mechanic, punctual and attentive to his duties; men without energy need not apply.—Address, stating full particulars as to age, experience, wages required, &c., to F. W. TALBOT, Waterworks, Frimley Green, Farnborough, Hants. 2264

Wanted, Position in Good Engineering or other works as COMMERCIAL MANAGER, CHIEF ACCOUNTANT, or SECRETARY. State terms.—Address, P455, Engineer Office, 33, Norfolk-street, Strand, W.C. P455

A Young Engineer, with 12 years' experience of all branches of railway engineering in Argentina and Brazil, and speaking Spanish and Portuguese, is DESIROUS of obtaining a POSITION of CONFIDENCE on an English-managed Railway in Spain or Portugal.—Inquiries to M., Medina, Milltown Malbay, Co. Clare, Ireland. P546

Engineer (28), Speaks Fluently French and German, SEEKS ENGAGEMENT. Specialist for coal mining, sizing and washing plants; elevating, conveying, and loading machinery for any minerals; two years in a high-class firm at Westphalia, WISHES POSITION.—Address, P545, Engineer Office, 33, Norfolk-street, Strand, W.C. P545

Engineer (30), Chief Constructor in one of the first smelting works in Austria, thoroughly experienced in the establishing of mining and smelting machinery, and in the construction of machinery in general, DESIRES SINGLE-HANDED POSITION. Advertiser has the best references, and is conversant with the German, English, French, and Russian languages.—Address, W. W. 3043, care of Rudolf Mosse, 2, Seilerstätte, Vienna I. 2178

English Engineer (38), for the last 15 years in full charge of textile machinery, steam plant (superheaters), dynamos, repairing workshops, buildings, &c., in one of the largest textile concerns on the Continent, DESIRES a SIMILAR SITUATION in England or abroad. Address, 2273, Engineer Office, 33, Norfolk-street, Strand, W.C. 2273

Mechanical Engineer, with seven years' experience in works and drawing-office, REQUIRES APPOINTMENT; experienced in marine and high-speed engines, boilers, launches, tugs, laying down plant in power stations; had some control of men; requires position of trust as clerk of works or assistant engineer; Stud. Inst. C.E.; speaks French.—Address, 2106, Engineer Office, 33, Norfolk-street, Strand, W.C. 2106

Young German Technician (Engineer's diploma); seven years' workshop and office practice in general machinery construction, breweries, and electric light and power installations, also experience in patent cases, WANTS SITUATION at once or later in England or English Colonies; good testimonials and refs.—T. U. 6205, Rudolf Mosse, 138 Alt Moabit, Berlin. 2256

South Africa.—A Gentleman, practical in iron, steel, and allied trades, who is shortly going out on behalf of his firm to make a tour of the mines and factories, &c., is OPEN to REPRESENT a few good FIRMS in the above lines.—For particulars, address, P511, Engineer Office, 33, Norfolk-street, Strand, W.C. P511

Articled Pupil.—The Borough Engineer of Dover, Mr. H. E. Stilgoe, A.M.I.C.E., has a VACANCY for a PUPIL in his OFFICE; experience in electric tramways, waterworks, sewerage, &c.—Address, 2193, Engineer Office, 33, Norfolk-street, Strand, W.C. 2193

Engineering Pupil. — Firm Government Contractors, employing 500 hands, have VACANCY; varied classes of work done, affording excellent opportunities; premium moderate.—Address, B415, Engineer Office, 33, Norfolk-street, Strand, W.C. B415

Wanted, Partner with Capital, or PUSHING MANAGER, to TAKE a SHARE in small SHIPYARD capable of development.—Address, P480, Engineer Office, 33, Norfolk-street, Strand, W.C. P480

£5000 Required to Complete the FORMATION of a SYNDICATE to take over an Engineer's Merchants Business in the North. It is desirable that one gentleman should invest £2000, and be prepared to take over the management, and preferably a good Engineer and Commercial Man.—Address, 2220, Engineer Office, 33, Norfolk-street, Strand, W.C. 2220

Appointments as Inspectors of WEIGHTS and MEASURES may be obtained by men over 21 who will qualify for Board of Trade Exam. Salaries £100 to £360. Full particulars free.—Write, INSPECTOR of WEIGHTS and MEASURES, Oakham Rutland. A11

A Firm of Consulting Engineers in Glasgow are PREPARED to ACCEPT a few First-class AGENCIES; only Firms of good standing can be represented.—1420, WM. PORTEOUS and CO., Glasgow. P499

Agents Required for Olivoline in DISTRICTS UNREPRESENTED. A perfect lubricating oil, durable and non-gumming; 30 years in use.—DUNCAN, WATSON and CO., Oil Refiners and Wagon Sheet Manufacturers, Dashwood House, New Broad-street, London, E.C. Y380

Gentleman having very Good connection in Sheffield and district with steam users DESIRES to SELL on COMMISSION for first-class Oil, Engine Packing, and Waste firms.—Apply in first instance to CHARLES PADLEY, Soucitor, Sheffield. P551

Steam Engine Accessories.—The Patentee of a cheap, highly efficient, and independently tested OIL SEPARATOR wishes to make ARRANGEMENTS with an advertising Manufacturing Firm for INTRODUCING this SPECIALITY in Great Britain and Colonies.—Address, P542, Engineer Office, 33, Norfolk-street, Strand, W.C. P542

South Africa.—Good City Firm with A1 South African connection and agencies is OPEN to TAKE UP IMPORTANT SPECIALITIES suitable for South Africa as Sole Buying Agents.—Apply, with full particulars, to AFRICA, care of Davis and Ornstien, Advertising Agents, St. Swithin's-lane, London, E.C. P510

The Advertiser, who is Doing a large business in machine tools, &c., with engineers and merchants abroad and in the Colonies, WISHES to MEET with a FIRM of TOOL MANUFACTURERS who are DESIROUS of EXTENDING their BUSINESS by doing a direct trade with foreign and colonial consumers.—A. B., 454, care of Deacon's, 154, Leadenhall-street, E.C. 2285

For continuation of Small Advertisements see pages II., III., IV., *and* LXVIII.

*** *Index to Advertisements page* LXVII.

Electric Installation, Ready for

DELIVERY, consisting of Mather and Platt MULTIPOLAR DYNAMO, 250 volts and 1400 ampères at 105 revs., and Galloway 600 H.P. VERTICAL ENGINE, cylinders 18in. and 34in., stroke 36in., Corliss valves.—For full particulars and price, apply GALLOWAYS LIMITED, Manchester. Y775a

Rope Fly-wheel, 20ft. Diameter,

grooved for nine 1¼in. ropes, weighing 12¾ tons; low price; READY for IMMEDIATE DELIVERY.—Apply, GALLOWAYS LIMITED, Manchester. Y775a

Electric Motors, Nearly New, in

most cases fitted with raw hide and steel double reducing gear, as follows:—

One ½ H.P. B.T.H. 115 v. × 1200 revs.
Three 2 H.P. B.T.H. 115 v. × 1800 revs.
One 1 H.P. B.T.H. 115 v. × 1000 revs.
Two 3 H.P. B.T.H. 110 v. × 1630 revs.
One 2½ H.P. Crompton 110 v. × 580 revs.
One 3 H.P. A.E.G. 150 v. × 740 revs.

Also One 100 amp. Dynamo × 110 v. and a 52-cell Battery.

One 9 B.H.P. Crossley's Otto Gas Engine, in excellent condition, with two tanks, exhaust, and all accessories.

One 12 B.H.P. Crossley's Otto High-speed Gas Engine, specially designed for electric generation, also in good condition, with four tanks, two exhaust chambers, and all accessories.

Would be sold as a whole or in part. Reason for selling, alteration in system of driving.

Address offers to the

ERA PRESS, Leyton, P457

where plant may be seen at any time by appointment.

For Hire, Pumps and Well-

BORING TOOLS for Contractors, Deep Wells, &c., 2in. to 24in. diam.—E. RICHARDS and CO., Upper Ground-street, London, S.E. Telephone No. 978 Hop. S22

For Patent, Steam, Electric, or

HAND PILE DRIVERS apply to NEW SOUTHGATE ENGINEERING CO. London office, 69, Victoria-street, Westminster. P140

For Sale:—

Pair of 21in. Horizontal Side-by-side Tandem CONDENSING ENGINES.
30in. Horizontal Tandem CONDENSING ENGINE, high-speed governors.
25 H.P. Compound S.C. ENGINE, 10in. × 16in. × 20in. stroke.
Compound Side-by-side Vertical S.C. ENGINE, 6½in. × 12½in. × 8in. stroke.
High-pressure Horizontal ENGINE, 24½in. cyl., 48in. stroke, fly-wheel 13ft. diameter.
16 H.P. Horizontal ENGINE (by Marshall and Co.).
Four 20 H.P. Crossley GAS ENGINES.
Two 12 H.P. ditto ditto.
Electric Light ENGINE and DYNAMO, 220 amps., 55 volts.
Vertical ENGINE and DYNAMO.
Nearly New WATER-TUBE BOILER, about 500 H.P.
CORNISH BOILERS, 12ft. × 5ft., for 120 lb. w.p.
Three MARINE BOILERS, 10ft. 7in. × 11ft. 7in. diameter, for 90 lb. w.p.
Send for free copy of the "Albion Machinery Catalogue." Contains the greatest quantity of machinery actually in stock.
Machinery Let Out on Hire, or Sold on Purchase Hire. Send for Catalogue. Inspection Invited.

THOS. W. WARD,
ALBION WORKS, SHEFFIELD.
Telegraphic Address: "Forward, Sheffield." 4101

For Sale, Bolt and Stud Lathes,

Smith and Coventry's patent, three 7in. centre single gear and one 8in. centre double gear, all in good condition.—I. COHEN and CO., 240, Blackfriars-road, London, S.E. A23

For Sale, Cheap.—

THREE DAVEY, PAXMAN'S ECONOMIC STEEL BOILERS, 13ft. 6in. × 7ft. 6in. dia., 74 tubes 3¼in. dia., now working at 145 lb. pressure, all fittings.

One Ditto, by Amos and Smith, 13ft. 6in. × 9ft. dia., 89 tubes 3¼in. dia., now working at 145 lb. pressure, all fittings. Water-softening Plant for above all complete. 1261

Apply, SHAW AND GASKELL, HULL.

For Sale, Cheap, to Save Cost

of removal, the following ELECTRIC LIGHTING PLANT, in first-class working condition and suitable for a Gentleman's Mansion:—

LOCO. TYPE BOILER, 10 N.H.P., by Marshall; twenty-eight 2in. tubes, fire-box; in good order. Two water gauges, steam gauge 200 lb., double spring safety valve, Buffalo injector, check valves, steam valve, short stack.

12 N.H.P. COMPOUND MARSHALL ENGINE, cylinders n. and 10in. by 14in. stroke; Hartnell governor; automatic expansion on H.P. cylinder; fly-wheel, 6ft. by 10in.; pulley, 5ft. by 7½in.; and pulley, 24in. by 13in.; automatic sight-feed lubricator on H.P., automatic lubricator on L.P. cylinder; steam trap; speed, 140 revs. per min.

FEED-WATER HEATER, by Marshall, to sit above boiler, 5ft. 8in. high by 15in. dia.

One Crompton Compound-wound DYNAMO, 120 ampères, 100 volts, pulley 10in. by 10in., feed drop lubricators, speed about 1100.

One Crompton Compound-wound DYNAMO (convertible to shunt), 35 ampères, 100 volts, fly-wheel pulley, slide rails, complete.

Two Worthington DUPLEX PUMPS, suitable for feeding boiler, size 3 by 2 by 3.

Plant available after July, and special arrangements have been made for carting to railway station.

For prices and particulars and orders to view apply C. E. and H. M. PEEL, Ltd., Swansea. 2184

For Sale:—Compound, Vertical

Inverted ENGINE, massive pattern, cylinders 12in. and 20in. by 20in. stroke.
Vertical Inverted high-pressure ENGINE, cylinder 12in. by 12in. stroke.
One Allen's Patent STEAM STRIKER.
GAS ENGINE, ½ to 16 H.P. nominal; good order.

FIELDING AND PLATT, LIMITED,
GLOUCESTER. Y344

For Sale, Hand-power Revolving

MASTING SHEARS, in good working condition; to lift 20 tons 80ft. high at a radius of 59ft. Also Cast Iron SWING BRIDGE, 50ft. span and 22ft. wide.—Apply, S. PEARSON and SON, Limited, Queen's Dock, Liverpool. 1975

For Sale, Horizontal Compound

CONDENSING ENGINE, 50 H.P.; removing to be replaced by larger engines; also CORNISH BOILER, 16ft. × 6ft. 9in., working above engine; 60 lb. pressure.—Both can be seen working at, to whom apply, TUBBS, LEWIS and CO., Wotton-under-Edge, Glos. 1227

For Sale, Locomotive Tank

ENGINE, made by Peckett's, Bristol; nearly new, 12in. cylinders, four-wheel coupled; cheap.—Apply, MAYOH and HALEY, 12, Norfolk-street, Strand, London. 2108

For Sale, New Steel Lancashire

BOILERS, ready for immediate delivery:—
Six 30ft. × 8ft. dia., for 100 lb. working pressure.
Two 30ft. × 8ft. 6in. dia., for 100 lb. ditto.
Six 30ft. × 8ft. 6in. dia., for 120 lb. ditto.
Other sizes in progress.

SPURR, INMAN AND CO., LIMITED,
Calder Vale Boiler Works, Wakefield. X1870

For Sale.—One First-class

Second-hand Compound HORIZONTAL ENGINE, having cylinders 16in. and 28in. diam. × 30in. stroke, complete with expansion gear, governors, fly-wheel, &c. One nearly new Edwards' Patent AIR PUMP, 20in. diam., and one JET CONDENSER.—G. S. DE RITTER, Engineer, Limehouse, London. 2209

For Sale or Hire, Second-hand

PORTABLE and other ENGINES of various powers by good makers.—Apply, W. ALLCHIN, Limited, Globe Works, Northampton. L5

For Sale, Punching and Shearing

MACHINES, double and single-ended. Large stock.—HY. GITTUS, Midland Ironworks, Travis-street, Manchester. A10

For Sale, One 25 H.P.

PORTABLE ENGINE, by Barrow and Stewart, two cylinders, 11in. dia., 15in. stroke. ONE 25 H.P. SEMI-PORTABLE ENGINE, by Ruston, Proctor and Co., two cylinders, 11in. dia., 15in. stroke, with fore carriage and travelling wheels.—WALKER HILL and CO., Nottingham. 1903

For Sale or Hire:—

PORTABLE ENGINES, also HORIZONTAL and VERTICAL ENGINES and BOILERS, 2 to 30 H.P.
LOCO. STEAM CRANES.
STEAM WINCHES, HOISTS, MORTAR MILLS.
SAW BENCHES, WOODWORKING MACHINERY.
Every description of Contractors', Builders', and Saw Mill Plant, New and Second-hand.
Large Stock Shafting, Bearings, and Pulleys, &c.
E. HOUGHTON BROWN, M.I.M.E., Kingsbury Ironwork Ballspond, London. C1
Telegraph, "Spherulite, London." Telephone, No. 38, Dalston

For Sale or Hire:—

PORTABLE ENGINES, 6 to 30 N.H.P.
SEMI-PORTABLE ENGINES, 12 to 50 N.H.P.
TRACTION ENGINES, 5 to 10 N.H.P.
PLOUGHING ENGINES and Implements.
CENTRIFUGAL PUMPS.
SAW BENCHES and SAWS.
Immediate delivery from works for breakdowns, &c.

HENRY LEWIS AND SONS,
ENGINEERS, READING. Y711
Telegrams: "Lewis, Reading." Full list free.

For Sale, Punching and Shearing

MACHINE, 1¼in., gaps 24in. and 30in., two cranes fixed on top.—GEORGE DIMMACK and CO., 75, Buchanan-street, Glasgow. 2259

For Sale, Radial Drilling

MACHINE, 3ft. 6in. arm, to revolve the entire circle, planed tee slotted box table, machine cut driving gear, &c.—I. COHEN and CO., 240, Blackfriars-road, London, S.E. A27

For Sale, Three Splendid Multi-

TUBULAR BOILERS, 64 tubes, 4in. dia., in each, for 120 lb. pressure; first-class fitting.—Address, P541, Engineer Office, 33, Norfolk-street, Strand, W.C. P541

For Sale, Two New Sets of 9in.

and 18in. by 12in. Compound Surface Condensing ENGINES, of strong design and best workmanship.—Apply, DAVIS ENGINEERING COMPANY, Limited, Abingdon-on-Thames. 1680

For Sale, 7in., 8in., and 9in.

Centre, Self-acting, Slide, Surfacing, and Screw-cutting Gap LATHES, with cut gear throughout; these are strong and high-class tools specially constructed for MOTOR WORK, &c., where heavy cuts and accuracy are required. Inspection of stock invited.—I. COHEN and CO., 239, 240, 241, Blackfriars-road, London, S.E. 754

For Sale, 14in. Centre, Double-

geared, Powerful Self-acting, Slide, Surfacing, and Screw-cutting LATHE, 20ft. box end gap bed; cut gear throughout.—I. COHEN and CO., 240, Blackfriars-road, London, S.E. A29

For Sale, 30in. Triple Geared

LATHE, 24ft. bed, self-acting, compound, swivel rest, rack and pinion for shifting head; makers T. Shanks and Company, Johnstone.—M'INTYRE, Kirkcaldy. P550

Four 10-Ton Steam Travelling

CRANES, span about 43ft., for SALE on account of being replaced by electric cranes. All in good working order, and can be seen in operation at any time by appointment.—THOMAS ROBINSON and SON, Limited, Engineers, Rochdale. 1172

Horizontal Cylinder Boring Mill

with 5¼in. × 11ft. 3in. S. A. Boring Bar; 5 cwt. D.A.S.A. STEAM HAMMER, Massey type.—JOHNSON, Sumner-lane, Barnsley. Y496a

Launch Boiler, 6ft. by 4ft.

(120 lb.) with dome; Willans' THREE-CRANK ENGINE, Vauxhall PUMP, and connections—together or separate. Bargain.—TUCK and CO., Ltd., Dublin. 2213

Locomotives for Sale, Hire, or

HIRE-PURCHASE.
THOROUGHLY OVERHAULED AND TESTED.
Ready for instant Despatch.
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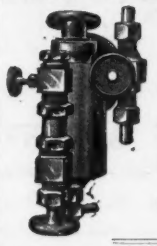

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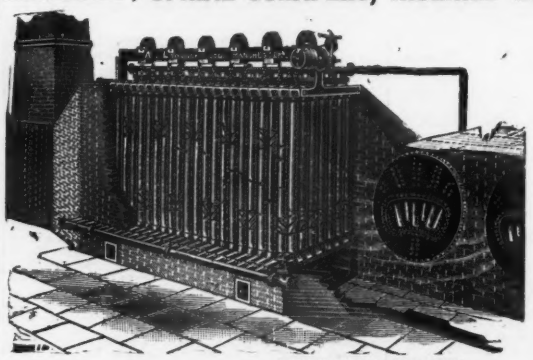

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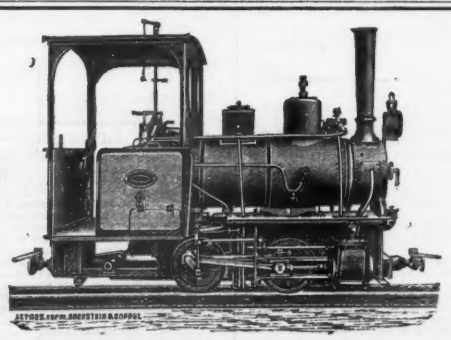

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For Sale, as a Going Concern, owing to dissolution of Partnership, an IRONFOUNDERS and ENGINEERING BUSINESS, situated in a large seaport on the East Coast, doing a good and increasing local trade, and making a speciality of brick machinery; or would take a new partner to replace retiring one. A good opening for an energetic man having some knowledge of the business.—Address, 2124, Engineer Office, 33, Norfolk-street, Strand, W.C. 2124

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For Sale by Private Treaty, the extensive BUSINESS PREMISES known as the Boxley-road Works, in a good situation, near the Chatham and Dover Railway Station, well adapted for any business requiring large space, comprising substantial buildings, chimney shaft, convenient offices and large yards, having a frontage of 136ft. 6in. to Boxley-road, and occupying an area of about 3325 square yards. The whole is in hand, and possession will be given on completion of the purchase.—For full particulars and orders to view apply to Messrs. TOOTELL and SONS, Estate Agents and Surveyors, 13, King-street, Maidstone. 1691

For Sale, Victoria Foundry ESTATE, Water-lane, Holbeck, Leeds, containing a site of 6024 square yards, either with or without the fixed machinery therein.—For particulars, and to view, apply Mr. RILEY, 64, Eiland-road, Leeds. 1720

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Preliminary Announcement.—Dismantling Sale of the Works of Messrs. Robert Stephenson and Co., Ltd., Forth Banks, Newcastle-on-Tyne, owing to Concentration and Removal of Locomotive Department to Darlington.—To LOCO., MARINE, and GENERAL ENGINEERS, MACHINERY DEALERS, BROKERS, and others.

Wheatley Kirk, Price and Co. have received instructions from Messrs. Robert Stephenson and Co., Ltd., to SELL by PUBLIC AUCTION the remaining portion of the BOILERS, ENGINES, SHAFTING, and MACHINERY in and upon the works, Forth Banks, Newcastle-on-Tyne, at an early date. The Motive Power includes ten Cornish, furnace and loco.-type boilers, five vertical and horizontal steam engines, shafting, pulleys, and bearings. The machinery consists of twenty-five lathes from 6in. to 36in. centres; four planing, seven slotting, and twelve vertical drilling machines; side planer, to plane 20ft. horizontally and 14ft. vertically; four horizontal boring machines; hydraulic flanging press; four punching and shearing machines; shaping, bolt-screwing, and emery grinding machines; ten steam hammers, from 5 cwt. up to 2 tons; two blast fans; twenty rope-driven and hand-power overhead cranes; numerous steam and jib and smiths' cranes, &c.—Catalogues are being prepared, and in the meantime further information can be obtained on application to the AUCTIONEERS, Albert-square, Manchester, and 46, Watling-street, London, E.C. 2275

Modern Electric Lighting Plant FOR SALE.
FIVE SETS WILLANS I.I. ENGINES, coupled direct to Mather and Platt Shunt-wound Dynamos, 1160 amperes, 105 volts.
ONE SET WILLANS H.H. ENGINES, coupled direct to Mather and Platt Dynamo, 370 amperes, 200 volts.
TWO SETS WILLANS G.G. ENGINES, coupled direct to Siemens Dynamos, 575 amperes, 105 volts.
FIVE SETS BRUSH VERTICAL COMPOUND ENGINES, coupled direct to Mordey-Victoria Alternators, 60 amperes, 2200 volts, periodicity 200.
All in first-class working condition; also
SIX BABCOCK-WILCOX WATER-TUBE BOILERS, W.I.F. type, each having total heating surface, 1827 sq. ft., total grate surface 35½ sq. ft., nine sections of nine 4in. diam. tubes, 18ft. long; steam and water drum, 23ft. by 36in. diam.; McPhail and Simpson's superheaters, all mountings and fittings and brick setting, for a working pressure of 150 lb. per sq. inch; and
ONE BABCOCK-WILCOX WATER-TUBE BOILER, W.I.F. type, total heating surface 2823 sq. ft., total grate surface 51 sq. ft., fourteen sections of nine 4in. diam. tubes, 18ft. long, steam and water drum, 23ft. 7in. by 36in., McPhail and Simpson's superheater, all mountings and fittings, for a working pressure of 160 lb. per sq. inch.
COMPLETE ELECTRIC LIGHT INSTALLATION FOR SALE.—High-class, equal to new, comprising Two 24 by 6 Lancashire Boilers for 100 lb. pressure, Berryman water heater, pump and connections; two Belliss compound engines, 5in. and 8½in. by 8in., coupled direct to Johnson and Phillips' Dynamos, each 105 volts, 190 amperes, or 135 volts, 160 amperes. Handsome switchboard; chloride battery of 19 accumulators, 300 ampere-hours. At present in public building; changing over to town supply. A bargain.
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Old-Established Profitable FACTOR'S BUSINESS for SALE OUTRIGHT; good home and foreign connection, steadily increasing turnover, and profits. Turnover roughly £18,000 per annum. Cheap and easy concern to manage. Will be sold a bargain. Price about £2500.—Particulars on application to No. 1282, Wheatley Kirk, Price and Co., 46, Watling-street, London, E.C. 2277

To Engineers, Brass Finishers, Machine Tool Makers, Machinery Dealers, and Others.—Hope-street, Halifax.
Davis and Shoesmith have received instructions from Messrs. Wilson, Feather and Co., Machine Tool Makers, who are declining business, to SELL by AUCTION, on the premises, as above, on FRIDAY, July 4th, 1902 (unless disposed of by private contract, of which due notice will be given), the whole of the stock of NEW ENGINEERS' TOOLS and WORKING PLANT, comprising 6 H.P. nominal Crossley's gas engine, on ashlar bed, with gas tanks and fittings complete, in perfect condition, and nearly new; six 8in. centre double-geared, self-acting, slide, surfacing, and screw-cutting lathes, on 8ft. gap and straight beds, by W. Feather and Co., quite new; three 6in. centre do. do., on 10ft. gap beds, by same makers, quite new; 2 double-geared, self-acting, slide, surfacing, and screw-cutting lathes, 9in. and 8in. centres, on 12ft. and 8ft. gap beds; 9in. centre double-geared screw-cutting lathe, on 15ft. gap bed; 10in. centre slide and surfacing lathe, on 12ft. straight bed; 11in. centre hand lathe, on 6ft. straight bed; powerful double-geared, horizontal boring machine, to admit 5ft. diameter, on 14ft. planed bed, with 3 standards, circular table and vice, by W. Feather and Co., with boring bars, cutters, &c.; self-acting planing machine, to plane 12ft. × 3ft. 6in. × 3ft. 6in. high; 12in. double-geared shaping machine, on 3ft. bed, nearly new, by Redman; 2 hand longitudinal travelling cranes, with Kropp's blocks and chains; Roots' blower, for two fires, blacksmiths' iron hearth with tuyere complete, lathe components, new parallel vices, and surface plates, steel tools, mandrills, files, screw keys, stocks, taps, dies, and reamers, shafting, and gearing, and gas piping throughout, together with the whole of the wood and iron models, for 30in. and 36in. drills, 12in., 9in., and 8½in. lathes, slotting machines, milling machines, &c., and blocks, electros, drawings, &c.; also the office furniture and effects, viz., Bundy's time recorder, fireproof safe, by Lumby, 28½in. × 20½in. × 20½in., Empire typewriter, &c.
Also, belonging to another estate, 7in. automatic revolving capstan lathe, with back chasing bar, &c., complete, nearly new; back-geared brake lathe, to swing between centres, 4ft. 6in. × 3ft., machine-cut gearing throughout, nearly new; 24in. 4-jawed chuck; square centreing machine, new; 9½in. and 9in. centres brass finishers' turret lathes, with reversing attachments; 7½in. centre hand lathe, compound slide rest for 12in. lathe, &c.
On view up to date of sale. Sale to commence at 11 o'clock in the forenoon prompt.—Catalogues may be obtained on application to the AUCTIONEERS.
Note.—The Auctioneers desire to draw attention to the exceptional character of this sale, most of the tools being quite new, and all are well worthy the consideration of intending purchasers.—Auctioneers' Offices, 10, Harrison-road, Halifax. 2132

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